RESEARCH REPORT 61

R5620 - 1.6F(A) 11/87

THE PILOT FOOD PRICE SUBSIDY SCHEME IN THE PHILIPPINES: ITS IMPACT ON INCOME, FOOD CONSUMPTION, AND NUTRITIONAL STATUS

Marito Garcia
Per Pinstrup-Andersen

August 1987

INTERNATIONAL
FOOD
POLICY
RESEARCH
INSTITUTE

The **International Food Policy Research Institute** was established in 1975 to identify and analyze alternative national and international strategies and policies for meeting food needs in the world, with particular emphasis on low-income countries and on the poorer groups in those countries. While the research effort is geared to the precise objective of contributing to the reduction of hunger and malnutrition, the factors involved are many and wide-ranging, requiring analysis of underlying processes and extending beyond a narrowly defined food sector. The Institute's research program reflects worldwide interaction with policymakers, administrators, and others concerned with increasing food production and with improving the equity of its distribution. Research results are published and distributed to officials and others concerned with national and international food and agricultural policy.

The Institute receives support as a constituent of the Consultative Group on International Agricultural Research from a number of donors including the United States, the World Bank, Japan, Canada, the United Kingdom, the Netherlands, Australia, the Ford Foundation, Italy, Norway, the Federal Republic of Germany, India, the Philippines, Switzerland, Belgium, and the People's Republic of China. In addition, a number of other governments and institutions contribute funding to special research projects.

Board of Trustees

Dick de Zeeuw
Chairman, Netherlands

Ralph Kirby Davidson
Vice Chairman, U.S.A.

Eliseu Roberto de Andrade Alves
Brazil

Yahia Bakour
Syria

Ivan L. Head
Canada

Dharma Kumar
India

Anne de Lattre
France

James R. McWilliam
Australia

Philip Ndegwa
Kenya

Saburo Okita
Japan

Sukadji Ranuwihardjo
Indonesia

Theodore W. Schultz
U.S.A.

Leopoldo Solís
Mexico

M. Syeduzzaman
Bangladesh

Charles Valy Tuho
Côte d'Ivoire

John W. Mellor, Director
Ex Officio, U.S.A.

THE PILOT FOOD PRICE SUBSIDY SCHEME IN THE PHILIPPINES: ITS IMPACT ON INCOME, FOOD CONSUMPTION, AND NUTRITIONAL STATUS

Marito Garcia
Per Pinstrup-Andersen

Research Report 61
International Food Policy Research Institute
August 1987

Copyright 1987 International Food Policy Research Institute.

All rights reserved. Sections of this report may be reproduced without the express permission of but with acknowledgment to the International Food Policy Research Institute.

Library of Congress Cataloging
in Publication Data

Garcia, Marito, 1951-
The pilot food price subsidy scheme in the Philippines.

(Research report / International Food Policy Research Institute ; 61)
Bibliography: p. 90.
1. Food relief—Philippines—Case studies. 2. Food consumption—Case studies. I. Pinstrup-Andersen, Per. II. International Food Policy Research Institute. III. Title. IV. Series: Research report (International Food Policy Research Institute) ; 61.

HV696.F6G36 1987 363.8'82'09599 87-17237
ISBN 0-89629-063-8

CONTENTS

Foreword

1. Summary 9
2. The Pilot Food Price Subsidy Scheme 12
3. The Study Areas 17
4. Assessment of Implementation 23
5. Analytical Methodology 27
6. Descriptive Analysis of Income, Consumption, and Nutritional Patterns 38
7. A Comparative Analysis of the Effects of the Food Price Subsidy Scheme 52
8. A Multivariate Analysis of the Effects of the Food Subsidy Scheme 62
9. Cost-Effectiveness Analysis 70
10. Conclusions 78

Appendix: Supplementary Tables 80

Bibliography 90

TABLES

1. Price discounts on rice and cooking oil and their share of the retail price, 1983/84 16
2. Study areas of the Philippine pilot food price subsidy scheme 19
3. Characteristics of sample households compared with the rest of the Philippines 21
4. Experimental design of the pilot food price subsidy study 29
5. Overview of the cost-effectiveness measures used in this study 35
6. Average incomes and income sources by province, survey round, occupation, and income quartile 39
7. Percent of total household expenditures on major commodity groups, by province, survey round, occupation, and income class, 1983-84 40
8. Proportion of the food budget allocated to various foods, by province, survey round, occupation, and income group, 1983-84 42
9. Diet composition by food groups, survey round, occupation, and income group, 1983-84 44
10. Calorie acquisition by food groups, survey round, occupation, and income group, 1983-84 46
11. Calorie intakes of groups of individual household members 48
12. Nutritional status of preschool children, 1983-84 51
13. Weekly food expenditures for each subsample and survey round, 1983-84 53
14. Change in household food expenditures due to price subsidy or nutrition education 53
15. Daily calorie acquisition for each subsample and survey round 54
16. Change in daily calorie acquisition due to price subsidy or nutrition education 54
17. Daily household calorie consumption for each subsample and survey round 55
18. Change in daily household calorie consumption due to price subsidy or nutrition education 56
19. Individual calorie adequacy by age and gender for each subsample and survey round 57
20. Change in calorie adequacy for selected groups of individuals due to price subsidy or nutrition education 58
21. Mean weight-for-age of all preschoolers for each subsample and survey round 60
22. Change in weight-for-age of preschoolers due to price subsidy or nutrition education 60
23. Mean height-for-age of all preschoolers for each subsample and survey round 61

24. Change in height-for-age of preschoolers due to price subsidy or nutrition education 61

25. Key coefficients for household food expenditure and food acquisition regressions 63

26. Parameters for estimating the impact of the pilot subsidy scheme on household food expenditures and calorie acquisition 64

27. Key coefficients and parameters for estimating the impact of the pilot subsidy scheme on the acquisition of rice, maize, oil, and fish 67

28. Regressions of calorie intake of children aged 13 to 83 months 68

29. Key coefficients for nutritional status regressions 69

30. Fiscal costs of the pilot food price subsidy scheme and their distribution 71

31. Estimated net impact of the pilot subsidy scheme on food acquisition and nutrition 72

32. Cost-effectiveness indicators 73

33. Cost-effectiveness comparison with other programs 76

34. Regression results for household food expenditures and food acquisition 80

35. Regression results for acquisition of rice, maize, oil, and fish 81

36. Regression results for calorie intake of children aged 13 to 83 months 82

37. Regression results for weight of children aged 13 to 83 months 83

38. Regression results for weight as a percent of standard weight-for-age, children aged 13 to 83 months 84

39. Regression results for height as a percent of standard height-for-age, children aged 13 to 83 months 86

40. Regression results for z-scores for weight-for-age, children aged 13 to 83 months 87

41. Regression results for z-scores for weight-for-height, children aged 13 to 83 months 88

ILLUSTRATIONS

1. Pilot food discount project delivery system 13
2. Map of the Philippines indicating study areas 18
3. Simplified version of the conceptual model underlying the analyses 27
4. Conceptual model underlying the multivariate analyses 30

FOREWORD

Food costs represent more than 80 percent of total expenditure for the poorest families in developing countries and are a significant budget item even for upper- and middle-income people. Hence, the provision of food subsidies as a means of income distribution in developing countries has had a strong attraction for policymakers. Subsidy costs compose as much as 15 to 20 percent of national budgets, providing important trade-offs among inflation rates, exchange rates, food subsidies, other types of income distribution measures, and development expenditures, which raise incomes in the longer run. In view of this, the International Food Policy Research Institute has, right from its inception, included studies of food subsidy schemes as a major part of its program.

If government expenditure on food subsidies is to be reduced, it is immensely important to know who the beneficiaries of food subsidies are, particularly regarding rural-urban distribution and the distribution among various income groups. There is considerable interest in the impact of various targeting schemes designed to ensure that a high proportion of the benefits go to lower-income people.

The research for this report by Marito Garcia and Per Pinstrup-Andersen was conducted in the Philippines in collaboration with the National Nutrition Council of the Philippines. It was financed by the United Nations Development Programme, the Government of the Philippines, and the U.S. Agency for International Development.

The particular focus of the study is the targeting of food subsidies to the poor by directing subsidies to regions with particularly high proportions of low-income people. Because administrative costs represent a large share of the cost of targeting, devices such as targeting by location help reduce these costs.

In keeping with the tradition of such studies at IFPRI, a carefully drawn sample of households is analyzed in detail to determine the impact of food subsidies. The study is designed to permit an analysis of the cost of the delivery system, and comparisons are made between this and other means of targeting. The results should be useful not only in the Philippines but in other countries that are contemplating means of reducing the cost and increasing the effectiveness of measures to increase the food consumption of low-income people. The study also analyzes the interaction of nutrition education with food subsidies, finding that nutrition education is much more valuable in conjunction with increased food consumption. This information should be useful in a developmental as well as a distributional context.

Although this study does not analyze the returns to expenditure on food subsidies if those returns have been spent in some other way, it provides a basis for such an examination by presenting comparative cost figures.

John W. Mellor

August 1987
Washington, D.C.

ACKNOWLEDGMENTS

This consumer food subsidy experiment would not have been possible without the support and cooperation of the Philippine National Nutrition Council (NNC) and its director, Delfina B. Aguillon, to whom we are grateful for continuous support throughout the study. The massive day-to-day logistical problems of running this pilot program fell squarely on the shoulders of the field personnel of NNC and the Ministry of Agriculture, who did an outstanding job. In particular, the home management technicians in the provinces of Abra, Antique, and South Cotabato were instrumental in the monitoring of the sample households and making sure that designated shops were open to sell rice and cooking oil at subsidized prices. They, too, were competent interviewers for the four consumption and socioeconomic surveys that were conducted as part of the study.

We gratefully acknowledge the assistance of the Nutrition Foundation of the Philippines and the Food and Nutrition Research Institute in training our survey teams. Melba Aligaen provided excellent organization of the supervisory and field survey teams along with Benilda Labayog, who was seconded to the project from the Bureau of Agricultural Extension. Minda Caedo was a great help in the initial design of the logistics of the subsidy experiment.

This report benefited from the valuable comments and suggestions from many colleagues including John W. Mellor, Jere Behrman, Harold Alderman, Joachim von Braun, Eileen Kennedy, and Gunvant Desai. We are also indebted to Elizabeth Jacinto and Fe Lisondra, who provided excellent computing assistance.

Finally, we wish to thank the United Nations Development Programme, the Government of the Philippines, and the U.S. Agency for International Development Mission in Manila, all of whom provided financial support for this research.

1

SUMMARY

This report presents the results of a pilot targeted food price subsidy scheme implemented in three provinces of the Philippines for 12 months beginning in mid-1983. It assesses the economic and nutritional effects of the scheme, analyzes its technical and administrative feasibility, and considers possible alternatives.

The scheme consisted of price discounts on rice and cooking oil and a nutrition education component. It was made available to half of 14 villages selected for their high incidence of malnutrition and poverty. The other half acted as a control population. Because targeting was geographical, all households in villages selected to receive the discount were eligible. Each household was issued a ration card indicating its monthly quota of rice and oil, based on family size. The rice ration subject to a price discount was only about half the amount usually consumed by most of the households, but the oil ration exceeded the amount usually purchased prior to the subsidy. Thus, consumer rice prices were not reduced at the margin, but oil prices were.

To evaluate its effects, one-third of the households from the selected villages were surveyed. Both comparative and multivariate analyses were made to estimate the impact of the scheme and its components on household food expenditures, acquisition, and consumption. Effects on consumption by preschoolers and their nutritional status were also monitored. Data on a variety of socioeconomic, environmental, and biological variables relating to food consumption and nutrition were collected before, during, and after the scheme. Two alternative methods were used to collect data on household food consumption. In the food acquisition method, called flexible period recall, all foods obtained by family members for a week were recorded. Under the food consumption method, all food consumed by household members was weighed for a 24-hour period. Food consumption by individual preschoolers was estimated on the basis of 24-hour food weighing for a subsample of the survey households.

The average monthly income of the sample households was 910 pesos, which is substantially lower than the Philippine average. Total expenditures of the sample households were 84 percent of total incomes, on average. The poorest showed a dissaving, while those who were better off were able to save significant amounts.

Although the total sample was drawn from agricultural and fishing villages in rural areas, only about one-third of the incomes originated directly from farming and fishing; almost one-half came from salaries and wages. Food accounted for 79 percent of total expenditures of the poorest quartile and 71 percent, on average, for the sample as a whole.

About 40 percent of the average food budget was spent on rice. Food expenditure patterns and diet composition differed considerably among occupational and income groups, with the poorest obtaining a larger share of calories from rice and maize. Average daily calorie consumption per adult equivalent unit (AEU) was 1,700 calories when based on 24-hour food weighing and 1,837 calories when based on flexible period recall. The 7 percent difference is explained primarily by the exclusion of weekends from food weighing.

Individual food consumption data collected from a subsample of 140 households indicate that the distribution of food within the households was biased in favor of adults. The calorie adequacy rate is estimated to be about 0.80 for adults, 0.60 for male preschoolers, and 0.55 for female preschoolers. School-age children and pregnant and lactating women also had low calorie adequacy rates.

The average weight of the sample preschoolers was about 83 percent of the standard weight-for-age. About one-fourth of the preschoolers were malnourished (less than 75 percent of the standard). Although most of the sample households were poor, the extent of malnutrition varied considerably among occupational groups. Forty percent of the preschoolers of hired fishermen were malnourished compared with 15 percent for professionals and salary earners. As income increased, malnutrition decreased, ranging from 30 percent among the poorest quartile to 16 percent among the richest.

According to the comparative analyses, the subsidy component of the scheme caused an increase in household food expenditures and calories acquired and consumed, as well as in calories consumed by most individual household members. Although adults obtained the largest share, the average weight of preschoolers also increased.

The second component of the scheme—nutrition education—had a small positive effect in households where it was accompanied by the subsidy. When education was provided without additional purchasing power, however, no effect could be detected. But the subsidy without the education component was still effective.

Multivariate analysis confirms and further refines these findings. The impact of the price subsidies on household food expenditures and acquisition was highly significant. Increased purchasing power, lower oil prices, and the subsidy itself all contributed.

The income elasticities of total food expenditures and total calorie acquisition indicate that a 10 percent increase in household incomes could result in a 7 percent increase in food expenditures and a 3 percent increase in calorie acquisition. Each additional peso of income from sources other than the subsidies is estimated to expand daily calorie acquisition by about 150 calories per AEU. However, an additional peso of purchasing power of food subsidies is estimated to result in an increase of about 230 calories. These findings indicate that consumers are more likely to increase their food consumption if foods are subsidized than if incomes are raised directly.

When multivariate analysis is employed, the nutrition education component of the scheme shows no significant impact on household food expenditures and acquisition, but food consumption and the nutritional status of preschoolers are strongly affected, indicating that the nutrition messages increased the focus on children.

Estimation of the effects of the scheme on the nutritional status of preschoolers is based on five indicators: weight; weight as a percent of standard weight-for-age; the z-score (a method of standardizing distribution) of weight-for-age; the z-score of weight-for-height; and height as a percent of standard height-for-age. The nutritional status of preschoolers was most affected by household incomes and calorie consumption—variables influenced by the subsidies.

The evidence indicates that the subsidy had positive effects on both households and preschoolers. The scheme resulted in net increases in household calorie acquisition of 136-138 calories per AEU per day, which is about 7 percent of current calorie consumption; in calorie consumption by preschoolers of 31-55 calories per child per day (4-6 percent of current consumption); and in the weight of preschoolers of 0.12-0.14 kilograms.

Eighty-four percent of the cost of the scheme was the subsidy itself. Administrative costs accounted for about 9 percent and the incentive payment to retailers to assure efficient distribution of subsidized food was about 7 percent. The fiscal cost of each $1.00 transferred to participating households was $1.19 in U.S. dollars. However, if only transfers to households with malnourished preschoolers are considered a benefit, the cost increases to $3.61. Similarly, the annual cost of a net increase in calorie consumption of 100 calories per AEU per day among all households is estimated to be $6.75 per AEU. The amount increases to $13.66 if only the food received by households with malnourished preschoolers is considered.

The annual cost of eliminating calorie deficiencies in the study population is estimated to be $25 per AEU. Adding 1 kilogram to the weight of each preschooler would cost $24 per year. If only weight gains among the malnourished are counted as benefits, the cost would increase to $56.

In comparison with other food and nutrition programs, the scheme's cost-effectiveness is favorable. Costs were low because, first, geographical targeting based on growth monitoring costs less than targeting based on household income levels; second, the use of existing private-sector retail outlets for the distribution of subsidized foods costs less than a separate distribution network; and third, the use and expansion of existing local bureaucratic structures cost less than the creation of a new and independent structure.

If the sole goal of such a scheme is to expand food consumption by households with malnourished preschoolers and to improve the nutritional status of these preschoolers, its cost-effectiveness could be significantly improved by additional targeting based on growth monitoring. However, the calorie adequacy rates of school-age children were almost as low, which casts doubt on the wisdom of targeting to one group of children alone.

Finally, the study finds a strong relationship between malnutrition and poverty. Groups such as landless farm workers and tenant farmers are most likely to be malnourished because of their limited purchasing power.

2

THE PILOT FOOD PRICE SUBSIDY SCHEME

Introduction

In 1980 the Philippine Ministry of Agriculture together with the National Nutrition Council and the National Economic Development Authority formulated the Philippine Food and Nutrition Plan (FNP) to provide the framework for action and research in nutrition, food consumption, and food production for the 1980s. The main objectives of the Plan were to increase and diversify the production of food and other agricultural commodities; to improve the quality of the diet of all Filipinos; and to assure a basic minimum diet for the undernourished. These objectives were to be achieved through the following broad strategies: stimulating the growth of the food economy; increasing export earnings and producing import substitutes; maintaining consumer prices at reasonable levels; and undertaking immediate programs to prevent malnutrition and to correct the most serious nutritional deficiencies, particularly calorie deficiency.

A food price discount or subsidy program was one of the immediate and short-term programs identified under the FNP to reduce calorie deficiencies among low-income households.[1] The scheme was conceived as a stop-gap measure aimed at bringing about immediate improvements in the energy intakes of malnourished individuals. Although viewed as a temporary measure, its phase-out was inextricably linked to the success of other elements of the FNP that seek longer-term solutions, such as increasing productivity and incomes of the beneficiaries, which would reduce the need for food subsidies.

The food subsidy scheme evolved out of the recognition that undernutrition cannot be solved effectively without expanding the ability of the poor to acquire food. Although the food production program of the government, particularly for rice, was a success, there were clear indications that these achievements, though important, were not sufficient to bring food consumption and nutritional status of the majority of the poor up to an acceptable level.

Past programs in nutrition have pointed toward direct intervention, such as supplementary feeding, health protection, nutritional rehabilitation, nutrition education, and family planning. Less attention has been focused on programs to improve the accessibility of food, particularly to the more deprived groups. Since 1981, a marketing scheme called KADIWA has been promoted to lower the costs of food in the main urban areas. The level of coverage, however, is low, and the scheme has reached only a small portion of the disadvantaged groups. Although the KADIWA program focuses on food, it has no expressed nutritional objective.

To assess the feasibility of FNP's proposed food subsidy program and to help assure that its design would be cost-effective, a one-year pilot scheme was implemented during 1983-84 in three provinces of the Philippines. The pilot program was specifically designed to permit its evaluation from viewpoints of incomes, nutrition, and technical and administrative feasibility. In addition to periodic surveys of selected households in the areas where the pilot scheme was implemented, data for the economic and nutritional assessments were obtained from extensive monitoring of all parts of the scheme. This report presents findings from the surveys and monitoring.

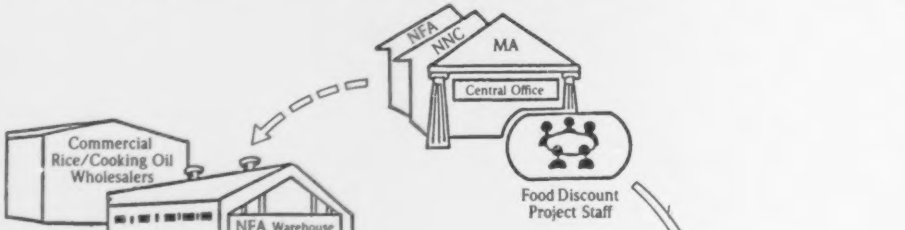
---

[1] Philippines, Ministry of Agriculture, National Nutrition Council, and National Economic and Development Authority, *The Philippine Food and Nutrition Plan for the 80s* (Manila: Ministry of Agriculture, 1980).

Description of the Pilot Scheme

The principal element of the pilot subsidy scheme was a reduction in the price of rice and edible oil offered for sale in selected areas identified as having high rates of malnutrition.[2] Nutrition education formed another element. Figure 1 is a simplified flowchart of the operation of the pilot food subsidy scheme. Each household in the project area was issued a ration (discount) card, which guaranteed a monthly quota of rice and cooking oil at a subsidized price. Participating families could use the ration card only in the accredited stores and only for the discounted purchase of rice and edible oil. The coded, nontransferable card, which showed the monthly quota of the household based on household size, provided space to record the purchases and signature of the store owner. For each sales transaction, the participating households were required to sign a sales logbook and the retailer was required to sign in a space provided on the ration card. The distribution and certification of the ration cards were handled by the Ministry of Agriculture through its local officers—the home management technicians (HMTs). Cards were valid for a period of one month, and they were issued at the beginning of each month.

Figure 1—Pilot food discount project delivery system


NFA
NNC
MA
Central Office
Commercial Rice/Cooking Oil Wholesalers
(Private)
NFA Warehouse
(Gov't.)
Food Discount Project Staff
Do Not Delay
Delivery Truck
Reimbursement of Discount Value
Rural Bank
Food Discount Project
Special Savings Deposit
List of Brgy. Residents
Sales Book
Verify and Monitor Sales
Barangay Store
Purchases
Monitor Purchases
Home Management Technicians
Barangay Licensed Grain Retailer (Private)
Food Discount Card
Target Beneficiaries

Note: NFA is the National Food Administration, NNC is the National Nutrition Council, and MA is the Ministry of Agriculture.

---

[2] These areas are described in detail in the next chapter.

The retail distribution outlets chosen for the pilot scheme were the neighborhood variety stores (called *sari-sari* stores) usually located within each village. The advantage of using local neighborhood stores in the scheme was their accessibility to the target beneficiaries. Locating the outlets in the neighborhood is compatible with the food-buying practices of the poor, who often buy food on a day-to-day basis and in small amounts. A study of such practices indicates that, among the very poor, small but frequent purchases are resorted to deliberately to ensure that food will not be consumed at once—a survival technique that allows families to stretch their budgets.[3]

Sari-sari stores are typically small, family-run enterprises that carry food, beverages, household items, tobacco and cigarettes, and other items that are normally sold in public markets. They perform a unique function in the life of the poor because they serve immediate needs of households. Without such outlets, households would have to buy from the nearest market town, which in many cases is far from the village.

Sari-sari stores normally operate with small revolving capital; not all are able to carry large quantities of rice. Under Philippine law, a license from the National Food Authority is necessary for any enterprise to sell grains. Under the pilot scheme, the local office of the Ministry of Agriculture followed a set procedure to select the *sari-sari* stores that would be accredited under the scheme. Among the criteria for selection were accessibility to participating households, size of revolving capital, license to retail grains, and acceptability of the retailer to local community leadership.

The ultimate distribution mechanism under the pilot scheme was left entirely to the private sector. Hence, the *sari-sari* store owner was responsible for the procurement of food commodities, as well as handling and final sales to the participating households. The function of the store owner was to serve all card-carrying participants within his designated area of jurisdiction. The government's role was to monitor the retail prices of subsidized food in the stores, audit their accounts for proper redemption of the subsidies, and reimburse retailers for the difference between the market price of the subsidized food commodity and the designated subsidized program price. The government depended on the services of the HMTs from the local extension office of the Ministry of Agriculture to carry out these tasks.

The *sari-sari* store owners procured subsidized rice and edible oils mostly from commercial sources, but in some instances they were procured from the government-owned National Food Authority. In general, store owners preferred to buy from the commercial sources where they were normally given credit.

The retailers were reimbursed for the subsidy only after the sales transactions were made. In return, the scheme provided an incentive to the retailers of 7 percent of the gross sales of the subsidized commodities. Subsidy accounting, which was done by the extension officer, was computed from the discount cards. These cards were redeemed every month along with the retailers' sales books. The program used local banks to reimburse the participating retailers. A special savings deposit account, which was opened in each area, was jointly held by the program office and the retailer. An accounting form called a discount reimbursement voucher was required for the twice-a-month withdrawal from the bank subsidy account. These vouchers helped the program office keep track of the accounts.

Selection of Food Commodities for the Scheme

The 1982 Second Nationwide Nutrition Survey carried out by the Food and Nutrition Research Institute (FNRI) indicated that the most important nutritional problem in the country was inadequate calorie intake. The average Filipino consumed 200-250 calories[4] below the recommended dietary allowances, and the problem was more severe among low-income groups.[5]

---

[3] Simeon G. Silverio, *The Neighborhood Sari-Sari Store,* Institute of Philippine Culture Poverty Series 2 (Quezon City, Philippines: Ateneo de Manila University, 1975).

In the light of these findings, two calorie-rich foods, rice and edible oil, were selected for the program. These foods contribute nearly two-thirds of the calorie consumption of an average Filipino. Rice was selected for the scheme because it is universally available and the preferred staple food in the country, composing 56 percent of the calorie consumption of the average Filipino.

Apart from these nutritional considerations, the use of rice was justified on economic grounds, rice having high income and price elasticities for low-income households.[6] In addition, the marketing system for rice in the Philippines is efficient and reaches even the most widely dispersed populations.

Edible oil from coconuts, on the other hand, is nutritionally important because of its caloric density. This is particularly critical in the case of infants and small children, whose digestive systems may be unable to absorb the necessary energy from diets that are based on a high-bulk food such as rice. FNRI considered the average annual consumption of 2.9 kilograms of vegetable oil per capita inadequate.[7]

The Size of the Subsidies

The amount of rice that target households could obtain under the pilot scheme was smaller than the amount consumed by most but not all households prior to the scheme: that is, it was inframarginal for most households. Under the scheme, each household member irrespective of age was entitled to 5 kilograms of subsidized rice per month. The average rice consumption of the targeted households before the start of the project was about 10 kilograms per capita per month.

The amount of edible oil, 400 grams per month, that each household member could obtain at the discounted price was higher than the average consumed prior to implementation of the scheme. The higher discounted quantity of edible oil reflected a government policy to expand its domestic consumption. The National Nutrition Council saw increasing consumption of edible oil in the diet of Filipinos as a strategy to narrow the calorie gap. FNRI concluded that the current share of oils and fats in the diet was too low, while the potential for its use was considerable because the Philippines is among the world's leading exporters of coconut oil.

The initial price subsidy was 32 percent for rice and 50 percent for cooking oil. These discounts were initially projected to transfer approximately 200-250 calories per person per day—a level that was computed directly from the food consumption elasticities available at the start of the pilot experiment. The initial plan was to maintain these percentage discount rates throughout the study period. In the latter half of the experiment, the last quarter of 1983, domestic consumer rice and oil prices increased abnormally—the rice price rose from 2.90 pesos (P) per kilogram to P 4.25 per kilogram, while the price of cooking oil doubled. Thus it was necessary to reduce the percentage of the retail price to be discounted in order to keep the cost of the scheme within its original budget. Further price increases were followed by a reduction in the percentage of the discount. The price discounts are given in Table 1.

Nutrition Education

The nutrition education component of the scheme was included as a complementary intervention to the price subsidy. The form of nutrition education adopted closely followed that used under the Philippine Nu-

---

[4] All calories referred to in this report are kilocalories.

[5] Philippines, Food and Nutrition Research Institute, National Science and Technology Authority, *Second Nationwide Nutrition Survey, Philippines 1982* (Manila: NSTA, 1984).

[6] Howarth Bouis, "Rice Policy in the Philippines" (Ph.D. dissertation, Stanford University, 1982).

[7] Ibid.

\

Table 1—Price discounts on rice and cooking oil and their share of the retail price, 1983/84

Period	Price Discount as a Percent of Retail Price: Rice	Price Discount as a Percent of Retail Price: Cooking Oil	Price Discount: Rice	Price Discount: Cooking Oil
			(pesos/person/month)	
July–August 1983	32	50	4.95	2.25
September 1983–April 1984	29	45	4.90	2.25
May–June 1984	21	23	5.10	2.60
July 1984	19	22	5.15	2.60

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.
Note: The exchange rate in 1983/84 was U.S. $1.00 to P19.

trition Program, which had been in existence for 10 years at the time of the study. The method consisted of face-to-face extension education supplemented by handout materials for information dissemination.

The nutrition education in this scheme was aimed at changing behavior relating to food consumption, first, to encourage optimal use of the additional oil from the scheme; second, to ensure that food consumption and nutritional benefits would be realized from the rice and cooking oil subsidy; and third, to improve child feeding practices. The first two items were specific to the project scheme, while the third is standard in all of the nutrition education messages in the Philippine Nutrition Program. In this respect, the scheme's nutrition education messages and the desired behavioral changes differed from regular nutrition education in that nutrition education was used as a complement to, rather than as a substitute for, the subsidies.

Mothers, the primary audience of the nutrition education scheme, regularly attended mothers' classes. Outreach was high: only 15 percent of mothers in the study villages did not regularly participate. In households where cases of second- and third-degree malnutrition were identified, extension workers made monthly home visits.

The field workers used as educators in the scheme consisted of the HMTs of the Ministry of Agriculture supported by local paraprofessional volunteers, known as *barangay* nutrition scholars (BNS). All field workers had prior experience in nutrition education methods. Retraining of these workers for the pilot scheme emphasized the nutrition education messages. The central staff of the project monitored the scheme to attain uniformity in methods and messages across all of the treatment villages, to ensure that classes would be consistent, and to maximize attendance by mothers.

3

THE STUDY AREAS

Criteria for Site Selection

The pilot areas were selected from economically depressed provinces. Although no attempt was made to select a sample of areas representative of the country as a whole, the three provinces chosen were drawn from each of the three main geographical groupings: Luzon, Visayas, and Mindanao. The three provinces were Abra, located in the northern Philippines; Antique in the central part; and Cotabato in the south (see Figure 2). Four villages were selected from each of the three provinces. The rice and oil subsidies were implemented in two villages, and the other two were used as control (comparison) areas. In each of the provinces, nutrition education was introduced in one of the two subsidy villages and in one of the two control villages. In one of the provinces (Antique), two additional villages were selected to test the impact of a scheme using edible oil as the only subsidized commodity, with and without education. The number of the study villages was, therefore, 14. This sample size was largely dictated by research costs and the ability to maintain an acceptable level of control over experimental conditions, and it represents an incomplete experimental design in that not all combinations of treatment and controls were included. In selecting the villages, representation of the dominant socioeconomic and ecological environments in the country was considered, as well as the nutritional situation of the village's children, based on the anthropometric reports of the National Nutrition Council. The treatment and comparison villages within each province were chosen for maximum comparability in economic base, topography, demography, ethnic origin, infrastructure services, and other socioeconomic characteristics.

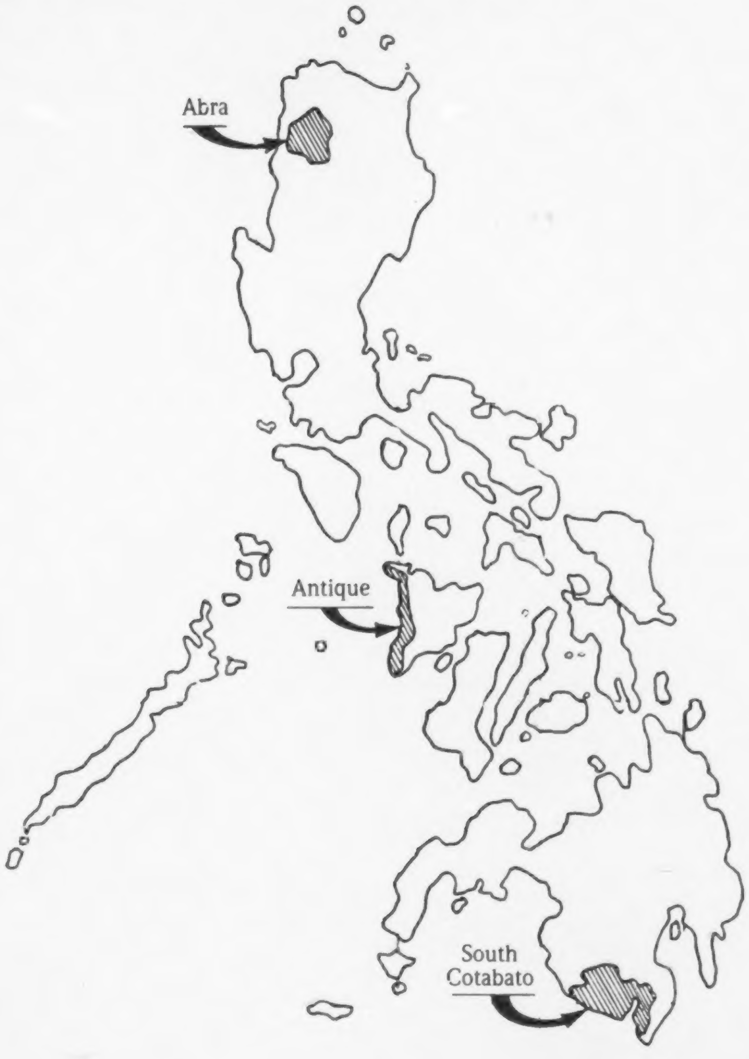
It should be noted that because an aim of the pilot scheme was also to test its administrative feasibility, the pilot areas were chosen to include a variety of infrastructural and extension service conditions. Hence, areas with both adequate and inadequate extension services and distribution outlets were represented.

As can be seen from the summary of characteristics of the pilot areas in Table 2, the various types of socioeconomic and ecological environments covered include upland, lowland, and coastal areas, and areas whose economic base varies, such as maize, rice, and coconut farming, fishing, handicrafts, and other indigenous industries.

Characteristics of Study Areas

The first group of study villages is located in the province of Abra in northern Luzon, situated approximately 450 kilometers north of Manila. The area is primarily in the uplands, generally mountainous with small patches of flatlands. The dominant source of livelihood is tobacco, maize, and vegetable farming, which accounted for 44 percent of total employment at the time of the study. Nearly half of all farmers owned land, but the average farm size of 2 hectares was less than half the national average. Because of the generally poor soil and hilly terrain, farm productivity was considerably lower than the national average. Some 15 percent of the population were engaged in livestock production, with freshwater (river) fishing as a secondary source of livelihood. About 21 percent of the household breadwinners were employed outside the province (7 percent overseas as contract workers or as seamen), mainly because of the limited economic opportunities in their home villages. The nonfarm labor force in Abra was absorbed by small home industries, by the informal and service sectors as wage earners

Figure 2—Map of the Philippines indicating study areas



(30 percent), or as professional and salaried workers in government and private sectors (10 percent).

The low household income per capita in Abra reflects the poor economic conditions in the study villages. Nearly three-fourths of household expenditures went to food, compared to 57 percent for the rest of the Philippines. The average family size in Abra was 6.30 people, and the average years of schooling were 7.06 years for fathers and 7.04 for mothers (Table 3). A third of all children were below 7 years of age, indicating a young population and a high dependency ratio. One of every five preschool children was either moderately

Table 2—Study areas of the Philippine pilot food price subsidy scheme

Study Provinces and Villages	Study Treatment: Rice and Oil Subsidy	Oil Subsidy	No Subsidy	Nutrition Education	1983 Population	Locational Characteristics	Economic Base	Ecology
Province of Abra								
Tangadan (San Quintin)	x				1,078	20 kilometers from provincial capital along main road; accessible through main road	Maize, tobacco, and livestock production; firewood	Upland and mountainous
V. Mercedes-Pobl (San Quintin)	x			x	1,211	15 kilometers from provincial capital along main road	Maize, tobacco farming	Upland and mountainous
Quillat-Baac (Langiden)			x	x	621	8 kilometers from provincial capital; accessible by boat across the river	Maize, rice, tobacco, vegetable farming	Upland and mountainous
Nalnas Poblacion (Langiden)			x		718	16 kilometers from provincial capital; accessible by boat	Fishing on river banks, maize, rice farming	Upland and mountainous
Province of Antique								
Funda (Hamtic)	x				1,360	12 kilometers from provincial capital; accessible by main road	Sustenance fishing, rice, coconut, farming, wages/professionals/service workers	Coastal area
Guintas (Hamtic)	x			x	1,251	8 kilometers from provincial capital; accessible by main road	Fishing, rice, coconut, vegetable farming	Coastal area
Butuan (Anini-y)		x		x	880	65 kilometers from provincial capital	Fishing, services, marginal farming of rice	Coastal area
Bayo (Anini-y)		x			917	70 kilometers from provincial capital	Fishing, services abroad, native industries	Coastal area
Magcalon (San Jose)			x	x	507	3 kilometers from town center	Fishing, rice, maize, and vegetable farming, wages/professionals/service workers	Coastal area

(continued)

Table 2—Continued

Study Provinces and Villages	Study Treatment				1983 Population	Locational Characteristics	Economic Base	Ecology
	Rice and Oil Subsidy	Oil Subsidy	No Subsidy	Nutrition Education				
San Fernando (San Jose)			x		687	5 kilometers from town center	Rice farming, professionals/ service workers	Coastal area
Province of South Cotabato								
Bolomala I (Tupi)	x			x	1,062	80 kilometers from main city	Maize, rice farming, cottage industries	River basin, flat
Bololmala II (Tupi)	x				852	85 kilometers from main city	Maize farming, cottage industries	River basin, flat
Colongulo (Surallah)			x		1,818	30 kilometers from provincial capital	Maize farming	River basin
Tubi-Allah (Surallah)			x	x	1,746	35 kilometers from provincial capital	Maize farming	River basin

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

Note: The places in parentheses are municipalities.

Table 3—Characteristics of sample households compared with the rest of the Philippines

Characteristic	Abra	Antique	South Cotabato	Average for the Philippines
Population of study areas, 1983	3,628	5,682	5,478	. . .
Number of households in sample survey[a]	240	360	240	. . .
Household characteristics				
Household size	6.30	6.52	6.41	6.14[b]
Adult equivalent units (AEU)	4.96	5.07	5.09	4.80[b]
Years of schooling, father	7.06	7.06	6.25	n.a.
Years of schooling, mother	7.04	7.53	6.74	n.a.
Per capita income (P/year)	1,680	1,768	1,505	n.a.
Percent of income spent on food	71.13	60.37	71.60	50.20[b]
Percent of expenditures spent on food	73.90	69.50	71.00	57.00[b]
Calorie acquisition in AEUs	1,818	1,915	1,736	. . .
Calorie intake in AEUs	1,755	1,720	1,613	1,808[c]
Calorie deficit in AEUs	327	383	410	224[c]
Occupation of main income earner			(percent)	
Farmers with land	23.64	6.80	27.30	14.20[b]
Tenant farmers	12.68	1.90	17.69	n.a.
Landless farm laborers	7.38	3.47	21.41	19.70[b]
Wage earners	30.66	29.45	20.89	29.30[b]
Fishermen	4.43	14.62	4.87	8.60[b]
Professionals/salaried	10.22	24.52	1.00	17.00[b]
Employed overseas	7.14	11.07	5.76	1.10[b]
Others	3.81	7.74	1.79	10.10[b]
Characteristics of preschool children[e]				
Percent of all children below 6 years	33.30	27.36	32.58	26.09[b]
Mean weight as percent of standard for age	82.84	82.71	83.09	84.0[d]
Percent of children second and third degree malnourished	20.72	26.46	23.19	17.2[d]
Mean Z-scores for weight for age	−1.60	−1.72	−1.68	n.a.

Sources: Data for the three provinces were collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines. Averages are taken from the sources indicated below.

Notes: The z-score is a method used in standardizing the distribution of actual weight of the child relative to the standard weight for a child of that sex and age. The standards devised by the U.S. National Center for Health Statistics (NCHS) were used in the study. n.a. means not available.

[a] This is the number of households randomly selected to be surveyed at the start of the experiment, 1983.

[b] Philippines, National Economic and Development Authority, *Philippine Statistical Yearbook* (Manila, NEDA, 1984).

[c] Philippines, Food and Nutrition Research Institute, *Nationwide Food Consumption Survey*, 1985.

[d] Strictly speaking, these results taken from Philippines, Food and Nutrition Research Institute (FNRI), are not comparable to the data for the three provinces included in the survey because FNRI uses Philippine child growth standards, whereas the study uses international (NCHS) standards.

[e] These data are from the first survey round.

or severely underweight—a higher figure than in most parts of the country.

The second group of pilot villages is located in Antique, a province on the island of Panay in the central part of the Philippines. The villages are situated along a narrow coast bounded by mountains to the east and the sea to the west. The area is one of the least arable in the country.

Because of the limited land resources, most of the area's population is engaged in nonfarm employment. At the time of the survey, about 30 percent were wage workers in local industries and crafts, 24 percent were salaried and professional workers, and 15 percent were fishermen. Only 12 percent of the heads of households in the study areas in Antique were engaged in farming, mainly in marginal maize, rice, and coconut production.

Per capita incomes in Antique were higher than in the two other pilot areas, but still below the national average. The 60 percent proportion of income spent on food was nearer the national mean than that of the two other areas. However, the incidence of second- and third-degree malnutrition, at 26 percent, was highest among the three pilot areas and particularly prevalent among small fishermen.

The third group of pilot villages is located in the province of South Cotabato, on the island of Mindanao. Located in a rich river basin, the area is one of the main maize-producing provinces in the country. In 1983, two-thirds of its population were engaged in farming, mostly growing maize used as animal feed. South Cotabato had a high tenancy rate; less than half of the farmers owned land, and 21 percent were landless farm laborers. About 20 percent of the heads of households were wage earners in secondary and service industries.

In the pilot areas of South Cotabato, the population is composed largely of second generation migrants from Luzon and Visayas. About 15 percent are natives (tribal minorities) who have been assimilated into the Christian population of immigrants. Per capita incomes in South Cotabato were the lowest among the pilot areas. The share of total income spent on food—72 percent—was high compared to the national average. Per capita calorie deficits exceeded 400 per day, and the native minority groups were the most affected by calorie inadequacy. Malnutrition among preschool children, estimated at 23 percent, was moderately high. Levels of educational attainment were also lower in South Cotabato than in Abra or Antique (Table 3).

Population Coverage of the Pilot Scheme

The total population of the study villages was 14,788 at the start of the experiment in May 1983. Out of these, some 1,407 households (8,611 people) received the subsidy, while the rest were treated as a control group. A total of 840 households with 5,376 members, or about one-third of the total population of the villages, were randomly selected for the pilot study. A total of 88 households out of the 840 households dropped out in the second round of interviews and hence were excluded from the study.

4

ASSESSMENT OF IMPLEMENTATION

The purpose of this chapter is to assess the effectiveness of the design of the scheme based on experience and monitoring. For a continuous period of 12 months, the pilot subsidy scheme was observed under actual operating conditions. This involved the monitoring of key participants of the program: the beneficiaries, retailers, wholesalers, participating banks, extension officers, and local political functionaries. The feasibility of the program instruments—ration cards, reimbursement vouchers, and sales logbooks—were tested under local conditions. A full-time study team from the central office of the National Nutrition Council, Ministry of Agriculture, and the International Food Policy Research Institute supervised the scheme for the entire period of operation. In addition, local extension officers were designated to provide periodic on-site monitoring.

The findings exposed a number of implementation problems that were not foreseen in the design of the scheme. The implications of these constraints are discussed here because they are critical to a possible larger-scale future program.

The Geographical Targeting Method

Eligibility for participation in a scheme that targets beneficiaries by geographic area is determined by residency. From an administrative point of view, the requirements for beneficiary certification in such a scheme are simple. For the pilot scheme, problems in verification of residence using the village census were few because families were usually known to the extension workers covering those areas.

Because the subsidized ration was based on household size, some families lied about the size of their households in order to draw larger quotas. To settle conflicting claims of household membership, cases were normally decided by the *barangay* captain, the local political leader. The *barangay* captain also decided whether families were bona fide residents of the *barangay* or precinct, entitled to participate in the program. At least 20 percent of the participating households padded reports of household size. There were a few migrant households and temporary settlers who were not in the census but were nevertheless included in the initial program listing.

Although area targeting is easier to administer than other forms of screening, such as income eligibility or sex and age criteria, several unanticipated effects were observed. A few households invited relatives from neighboring villages excluded from the subsidy into the targeted villages to share the subsidy benefits with them. This was observed only among the very poor households and only in the first half of the experiment. It is unlikely that large-scale population movements would occur as a result of an area-targeted subsidy such as this. However, movement would likely be proportional to the size of the subsidy envisioned. In the pilot study, the level of subsidization compared to incomes was quite low; hence the in-migration was limited.

The geographical area targeting scheme assured coverage for all the needy households in the depressed village because the subsidy was available to everyone within the area. The major disadvantage of such a method, however, is that poor households who live outside the target area are excluded, while well-off households and well-off individuals in deficit households in the area are included.

Possible Problems

Leakages

The goal of the subsidy scheme was to increase and sustain the ability of the food-deficit poor households to purchase enough food to meet nutritional requirements. By definition, therefore, program benefits that were lost in the process of implementation or that accrued to households that did not need them are considered "leakages." Alternatively, leakage can be defined as the difference between the value of food or cash transfer, and the value of the net increment of the food intake of the food-deficit or needy households.[8]

Several overt forms of leakage were observed in the pilot scheme. First, because the program did not discriminate against any household within a project village, households without a deficit (mostly higher-income households) in the villages were included in the program. Consequently, leakages were low if the majority of the households in the villages selected were calorie-deficit households. The efficiency of the area method of targeting is therefore a function of the national agency's accuracy in identifying poverty areas and the degree of geographical concentration of malnutrition. The food consumption survey conducted just prior to the enforcement of the scheme found that 73 percent of the households were deficient, which shows that targeting was relatively efficient.

In two villages in the south, a few economically well-off households shared their rations with poorer neighbors, thus reducing leakages. Some better-off households allowed their poor neighbors the use of their food discount cards, although discount cards, strictly speaking, were not transferable. These transactions, which were done with the knowledge of the store owners, involved no compensation.

During the 12-month monitoring period some cases of reselling of subsidized food were observed, although this was not rampant. All reselling cases involved cooking oil, which was attractive for the very poor families because the product commanded a good price in the open market. For instance, a family of six with a monthly allocation of 2.4 kilograms of cooking oil stood to gain about P 15 if it sold all its ration, an amount that was almost equal to half a day's wages. There was almost no resale of rice observed, mainly because rice is a staple food, and the ration for each family was only about half of what a typical household consumes.

In two villages in the north several enterprising households used all of their cooking oil ration in their small native delicacy business, not for home consumption. In a number of instances some retailers preempted the rations of households that did not consume all of their quota for the month. These practices were particularly difficult to check because the retailers could forge signatures in the salesbook records, and monitoring by the extension officers could only be done once a week.

Use of Food Discount Cards

Some problems were encountered in the use of the food discount ration cards in the retail stores. Two signatures were needed for every sales transaction in the stores: the retail store owner had to sign the ration card and the card holder had to sign the store salesbook. This procedure delayed the transaction, especially in the stores that served larger populations. Illiterate beneficiaries who could not sign the salesbook created another administrative problem. For this group—about 8 percent of the target households—a thumb mark was used to carry out the transaction. Another problem was generated by participants who in the first two months of the experiment deliberately changed the ration amount stated on the discount cards by tampering with the figures on the cards. These were easily detected when compared with the records of the stores.

Accountability and Controls

The use of local banks in the handling of subsidy reimbursements to the retail store owners was quite efficient and would probably be just as feasible in a larger program. The special savings deposit provided a convenient procedure for the redemption of the subsidies by the store owners. Because the size of the subsidy was predetermined from the potential number of beneficiaries, the amount transferred every month by the central program office into the deposit accounts was accurate to within 94 percent of the actual subsidies.

---

[8] The measurement of leakage is explicitly treated in Chapters 6 and 10.

The weekly auditing of the books in the store presented some difficulties at the start of the project, but once the extension officer and the retailer became familiar with the procedures, the accounting tasks progressed without exceptional problems. Part of the difficulty in the auditing procedure could be traced to the small but frequent purchases, which resulted in a large number of bookkeeping entries.

Administration of Food Outlets

The procurement and selling performances of the accredited neighborhood *sari-sari* stores varied by area. The differences in efficiency were dependent on a number of factors, including the size of the population served, frequency of purchase, amount of revolving capital and supply credit, the amount of credit extended to customers, the location of the store, and the character of the retailers and their community acceptance.

The outlets in Antique, which served a larger clientele, experienced more difficulty than those in the other two provinces. The queuing and crowding in the stores, especially during the heavy buying days, sometimes resulted in bookkeeping errors in these larger villages. The owners of the retail outlets indicated that, given the frequent purchasing habits of households, the optimum number that each storekeeper could efficiently handle was not more than 120 households, assuming that the store was attended to by the store owner and an assistant, who was usually an immediate member of the family.

In most areas poor households made frequent purchases but in small quantities. Many households, for example, bought cooking oil three times a day, and the purchases were as small as one-half cup (80 grams). Store records compiled for the project indicated that 28 percent of all households made daily purchases. This practice increased the transaction time in the stores per unit purchased. Most stores reported heavier selling late in the afternoons when the breadwinners arrived from work or when the day's fish catch was sold.

Stores that had more than P 10,000 (U.S. $900) of revolving capital were effective in maintaining uninterrupted selling operations. On the other hand, smaller stores experienced intermittent shortages in the supply of the commodities. Although weekly credit was available from commercial rice wholesalers, the amount allowed depended on the capitalization of the store. Hence, smaller stores were not assured of sufficient credit to meet the demand. On the basis of the 12-month store records, it is estimated that in order to support a client base of 120 families a retail outlet should put up an initial revolving capital of at least P 10,000 in 1983 pesos.

It was a common practice in neighborhood stores to give weekly credit to regular clients. Larger stores offered credit on the subsidized food, but the smaller stores did not because of limited revolving capital. Families located on the fringes of the subsidized villages experienced difficulty in obtaining subsidized food because of their distance from the stores. These families usually made one-time bulk purchases, but even so transport costs increased the total food acquisition cost of these beneficiaries. The geographical distribution of target households should therefore play a crucial role in the choice of outlets for a program.

In some instances neighborhood politics hampered the scheme's delivery mechanism. In Abra, for example, one retailer refused to sell subsidized rice to constituents not belonging to her political party. Another store owner refused to sell to people who had a long-standing feud with her family. Some cultural minority groups were not properly attended to in the stores in South Cotabato and were effectively denied their subsidized rations. However, more than half of the retailers were observed to be quite sensitive to community needs, even opening their stores late at night in order to serve their clients. Based on this experience, it is quite apparent that the choice of the retailer is crucial in program delivery. One of the important considerations in selecting an outlet is community acceptance of the retailers.

Subsidy Take-out Trends

Records compiled at the stores for the initial month of the experiment indicate that only 85 percent of the rations made available were claimed by the villagers, but this take-out rate increased to 95 percent after the third month. Households that did not get all of their subsidized food rations were those that had insufficient cash available during the month, were growing rice, or were too far from the stores to be able to take advantage of the lower price.

The rate of ration utilization varied by commodity. Almost all rice rations were taken but only 80-85 percent of cooking oil rations, probably because the cooking oil ration was larger than the amount consumed before the scheme, while the rice ration was not. Under these conditions, households can be expected to consume all of their rice allocations, but they may decide to buy only as much as or slightly more cooking oil than they used before, if reselling is difficult.

Monitoring

The monitoring clearly demonstrated that the efficiency of scheme implementation depended largely on adequate understanding by program participants of the program's objectives, mechanics, and benefits, and on the retail store owners' understanding of program procedures. Social preparation activities were conducted by local extension officers of the Ministry of Agriculture, assisted by the BNS. Monitoring of both the retail stores and the beneficiaries was done by extension officers as part of their work on the project areas. Prior to implementation, village assemblies were held to explain the scheme's mechanics and objectives. These assemblies were undertaken with the cooperation of the local political councils in the project areas.

There were no major difficulties in delivering nutrition education because all of the extension workers had prior experience in this type of intervention. Eighty-five percent of all mothers in the project areas attended nutrition education classes regularly. For the most part, the mothers who did not attend were unable to combine attendance with wage labor. It is difficult, however, to assess the degree of effectiveness across the villages because there were obvious differences in the abilities of the extension officers in delivering the nutrition education messages. The effects of nutrition education on the outcome variables (calorie intake and child nutrition) are discussed in Chapters 8 and 9.

In summary, except for a few details, the scheme's design as initially conceived was generally feasible from an administrative standpoint. Several important lessons were learned from the monitoring on ways to enhance its viability if the scheme were applied on a larger program level.

5

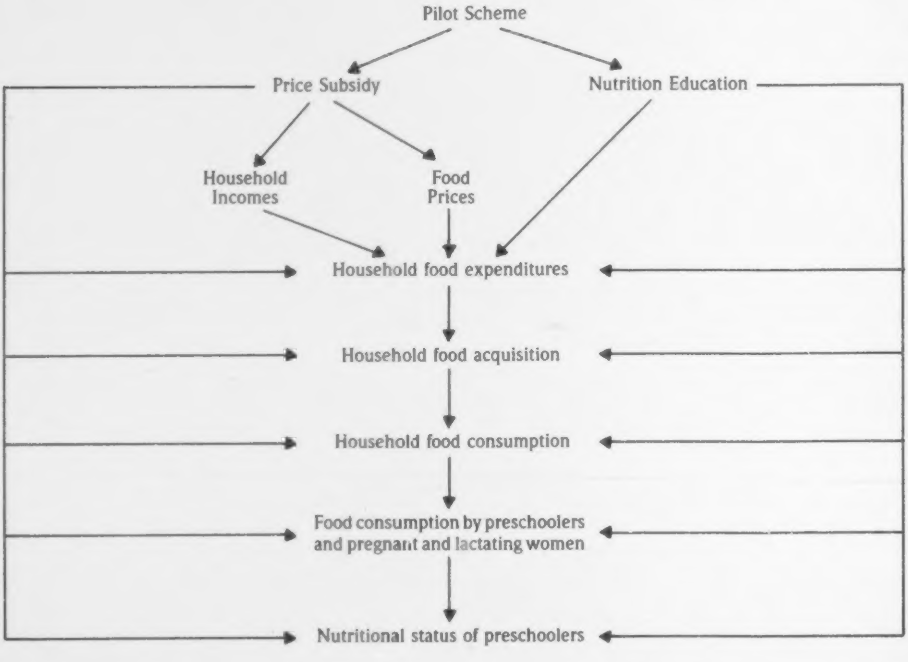
ANALYTICAL METHODOLOGY

The analysis of the impact of the pilot scheme on household food expenditures, acquisition, and consumption, and on food consumption and the nutritional status of preschoolers is based on a conceptual framework shown in a simplified version in Figure 3.

The price discount element of the scheme implies an increase in the real purchasing power or income of the recipient households. This increase can in turn be expected to increase household food expenditures, acquisition, and consumption. It may also result in increases in food consumption by the household members most likely to be calorie-deficient—preschoolers—and thus improve their nutritional status (Figure 3).

If the amount of subsidized rice or oil exceeds the amount that would be purchased by the households without the subsidies, the subsidies will reduce the price households pay for the last unit (at the margin). This could be expected to increase the consumption of the subsidized foods. These price-induced increases would not be expected, however, if the amount subsidized were less than the amount the household would purchase without the subsidies because the price at the margin would not be affected. The price subsidies may also affect food expenditures, consumption, and nutritional status directly through changes in household behavior.

Figure 3—Simplified version of the conceptual model underlying the analyses


Pilot Scheme
Price Subsidy
Nutrition Education
Household Incomes
Food Prices
Household food expenditures
Household food acquisition
Household food consumption
Food consumption by preschoolers and pregnant and lactating women
Nutritional status of preschoolers

The nutrition education component of the scheme may also affect food expenditures, consumption, and nutritional status by changing household behavior regarding food purchases, dietary patterns, intrahousehold food distribution, and other aspects. The effects of each of the two components—price subsidies and nutrition education—on each of the five indicators shown in Figure 3—household food expenditures, acquisition, and consumption, food consumption by individual preschoolers, and their nutritional status—are estimated by means of comparative static and multivariate analyses.

Comparative Analysis

The experimental design used in this study is illustrated in Table 4. Data were collected from four rounds of surveys in the 14 villages over a 17-month period. About two months after the first survey round was initiated, subsidized rice and oil were made available to survey villages in each of the three provinces. In addition, subsidized oil alone was made available to two villages in one of the provinces. The two other villages from each province that were included in the study were not given access to subsidized food; they served as controls. In each province, a nutrition education program was introduced in one of the two villages that received subsidies and one of the two that did not.

The second survey round was executed about 2 months after the introduction of the subsidy scheme, the third 12 months after the first, and the fourth and last round was undertaken about 2 months after the scheme was terminated, that is, 12 months after the second survey. The spacing of 12 months between surveys was done to avoid confounding effects of seasonal variations.

The control villages were selected to be as similar as possible to the "treatment" villages—those receiving subsidies. Thus, effects of exogenous variables that could not be controlled or accounted for in direct comparison are assumed to have the same effect on control and treatment villages and can therefore be separated from the effects of the scheme.

The effects of the subsidies and nutrition education are estimated simply by comparing the appropriate treatment and control villages after adjusting for differences prior to the introduction of the scheme (the treatment). Analysis of variance is used to test for significant differences. The percent change in each of the five indicators of interest due to subsidies and/or nutrition education is estimated:

$$A_i = [(T_i/C_i)/(T_1/C_1) - 1]\,100, \qquad (1)$$

where

A_i = percent change in the indicator for month i relative to the baseline value of the indicator due to the treatment, for example, the percent change in household food consumption due to nutrition education;

T_1 and T_i = average value of the indicator for round 1 (baseline) and month i for treatment households; and

C_1 and C_i = average value of the indicator in round 1 (baseline) and month i for control households.

The results of the comparative static analyses are presented in Chapter 7.

Multivariate Analysis

Results from comparative static analyses are suspect because the effects of other factors on the groups are not fully accounted for. Multivariate analyses suffer considerably less from this problem because the effects of many factors may be isolated from the effects of the pilot scheme. Therefore, in addition to comparative static analyses, multivariate analyses are used to estimate the impact of the scheme. These analyses are based on the conceptual model presented in Figure 4, which shows the variables hypothesized to influence the indicators and thus included in the multivariate analyses.

Table 4—Experimental design of the pilot food price subsidy study

Commodities Subsidized	Nutrition Education	Province	Survey Rounds			
			1[a]	2[b]	3[c]	4[d]
Rice and cooking oil	Yes	Abra	x	x	x	x
		Antique	x	x	x	x
		South Cotabato	x	x	x	x
	No	Abra	x	x	x	x
		Antique	x	x	x	x
		South Cotabato	x	x	x	x
No subsidy	Yes	Abra	x	x	x	x
		Antique	x	x	x	x
		South Cotabato	x	x	x	x
	No	Abra	x	x	x	x
		Antique	x	x	x	x
		South Cotabato	x	x	x	x
Oil only[e]	Yes	Antique	x	x	x	x
	No	Antique	x	x	x	x

[a] This was the baseline survey, 2 months prior to introduction of the scheme.

[b] This survey took place 2 months after introduction of the scheme.

[c] This survey took place 10 months after introduction of the scheme.

[d] This survey took place 2 months after the scheme was terminated.

[e] In two villages of one province, only oil was subsidized at the request of the Minister of Agriculture.

Household Calorie Consumption Functions

Four of the five indicators—household food expenditures and acquisition, and food consumption and nutritional status of preschoolers—are regressed on the variables shown in Figure 4 to estimate the effect of the price subsidies and nutrition education on each of the indicators and to isolate the effects of other variables hypothesized to influence these indicators. The impact of the price subsidies is measured partly through the increase in household incomes and the decrease in rice and oil prices and partly through a direct effect hypothesized to come about primarily because households treat the real income increase from food subsidies differently from other income increases—that is, the marginal propensity to spend on food differs between subsidy income and other real income.[9]

The general estimating model used to estimate the impact of the scheme on household food expenditures and acquisition is

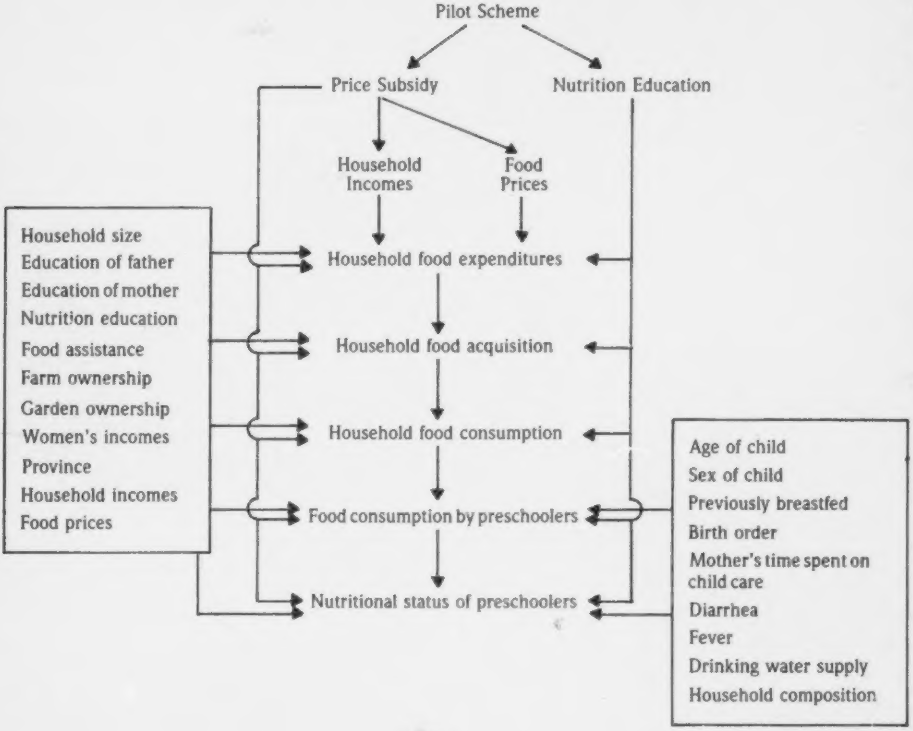
$$C = f(Y, S, P_R, P_o, NE, Z), \qquad (2)$$

where C is total food expenditure (or calorie acquisition), Y is real household income, S is the subsidy term, P_R and P_o are the real price of rice and cooking oil, respectively, NE is nutrition education, and Z is a set of other variables hypothesized to influence the dependent variable. Here the dependent variable is a composite of expenditures on all foods or an aggregation of total calories from all of the foods acquired by the household.

---

[9] Evidence of such differential treatment of subsidy income has been found for the U.S. food stamp program (Ben Senauer and Nathan Young, "The Impact of Food Stamps on Food Expenditures: Rejection of the Traditional Model," *American Journal of Agricultural Economics* 68 [February 1986]: 37-43). None has been found, however, for the Sri Lankan food stamp program (Neville Edirisinghe, *The Food Stamp Scheme in Sri Lanka: Costs, Benefits, and Options for Modification*, Research Report 58 [Washington, D.C.: International Food Policy Research Institute, 1987]).

Figure 4—Conceptual model underlying the multivariate analyses


Pilot Scheme
Price Subsidy
Nutrition Education
Household Incomes
Food Prices
Household size
Education of father
Education of mother
Nutrition education
Food assistance
Farm ownership
Garden ownership
Women's incomes
Province
Household incomes
Food prices
Household food expenditures
Household food acquisition
Household food consumption
Food consumption by preschoolers
Nutritional status of preschoolers
Age of child
Sex of child
Previously breastfed
Birth order
Mother's time spent on child care
Diarrhea
Fever
Drinking water supply
Household composition

The household-level estimating model is defined:

$$
\begin{aligned}
C_i/AEU = {} & b_o + b_1 Ln(Y_i/AEU) + b_2 S_i \\
& + b_3 HHsize_i + b_4 EducS_i \\
& + b_5 EducH_i + b_6 Nutredc_i \\
& + b_7 Nutrelv_i + b_8 Foodasst_i \\
& + b_9 Ownfarm_i + b_{10} Owngard_i \\
& + b_{11} PwomenY_i + b_{12} L_{2i} + b_{13} L_{3i} \\
& + b_{14} Price_i + b_{15} Poil + u_i, \qquad (3)
\end{aligned}
$$

where

C_i/AEU = food consumption of household i defined either as total food expenditure per adult equivalent unit (AEU), or as total calorie acquisition per AEU;

Y_i/AEU = total income per AEU of household i;

S_i = subsidy term defined either as a percent of total incomes, or as a dummy, 1 if households received the subsidy and 0 otherwise;

$HHsize_i$ = household size;

$EducS_i$ = educational level of the wife;

$EducH_i$ = educational level of the husband;

$Nutredc_i$ = a dummy defined as 1 if the household received nutrition education from government programs, 0 otherwise;

Nutrelv_i = a dummy defined as 1 if the household participated in the nutrition education classes under the pilot subsidy scheme, 0 otherwise;

Foodasst_i = a dummy defined as 1 if the household participated in food assistance programs, 0 otherwise;

Ownfarm_i = a dummy defined as 1 if the household owned a farm, 0 otherwise;

Owngard_i = a dummy defined as 1 if the household owned a garden, 0 otherwise;

PwomenY_i = proportion of total incomes contributed by women;

L_{2i} = location dummy for Antique;

L_{3i} = location dummy for South Cotabato;

Price_i = unit price paid for rice by the household; and

Poil_i = unit price paid for oil by the household.

The two alternative specifications of the subsidy are used to test the robustness of the estimates of the scheme's impact. Each of these implies different assumptions and levels of constraint imposed on the consumption function. The first alternative uses a proportion term (the subsidy as a percent of total incomes from all sources including the subsidy itself). If the coefficient of this subsidy term is not significantly different from zero, the marginal propensity to consume (MPC)—to acquire food—does not change with the changing proportion of total incomes coming from subsidies. A positive and significant coefficient would indicate that income transfers embodied in the scheme have a higher MPC than other household income, and vice versa.

The specification of a dummy for subsidy recipients is interpreted as a parallel shift in the relationship between consumption and income. Therefore, a positive and significant coefficient of the dummy subsidy variable would indicate an effect above the income effect. However, this subsidy variable predicts an impact that does not vary across income groups. This model is hence less intuitive, although empirically predictive of the subsidy effects at the mean level of income.

The use of an AEU scale in the food consumption and income variables explicitly accounts for the differences in household size and composition. The AEU approach is a refinement to the consumption per capita and income per capita approach, as it explicitly accounts for the differences of age composition of households.[10] For this study, the AEU scale used to translate family members of different ages into equivalent person units is derived from the Philippine recommended dietary allowances (RDAs) for calories for each sex-age group.[11] Thus, formulating incomes and consumption in AEUs allows flexibility in economies of scale and size and composition of households.

The income variable is specified in natural logarithm to allow for decreasing MPC for food with increasing incomes. Because of inherent problems in correctly measuring income, particularly in semisubsistence households, total expenditures were used as income proxy throughout the regressions. Because, as discussed in Chapter 8, household incomes are not strictly exogenous, the validity of the results is tested using wage rates instead of incomes.

The impact of the other component of the pilot scheme, the nutrition education intervention, is tested with a dummy variable equal to 1 if the household received the nutrition education and 0 if not. Various socioeconomic and locational variables are included as explanatory variables, specifically to isolate the effects of incomes and subsidies from other socioeconomic, demographic, and locational factors.

---

[10] S. J. Prais and H. S. Houthakker, *The Analysis of Family Budgets* (New York: Cambridge University Press, 1971); and Angus Deaton and John Muellbauer, *Economics and Consumer Behavior* (New York: Cambridge University Press, 1980).

[11] Food and Nutrition Research Institute, and National Nutrition Council, *Recommended Dietary Allowances for Filipinos* (Manila: FNRI, 1976).

The prices of rice and cooking oil used as independent variables in the regressions are data reported from the survey. In using the unit price for rice as an explanatory variable, the market price paid is used for households where the rice subsidy is inframarginal; in the extramarginal households the price used is the price that the households paid in the subsidy stores. Price, expenditure, and income variables are deflated by price indexes for the particular month when the survey was carried out, and for the particular region where the samples were located. The use of real values in the regressions is designed to separate the effect of the increase in real income through the subsidy scheme from an increase in expenditures through inflation. The first survey is used as the baseline (index = 100) in deflating the nominal values.[12] The results from the regressions are shown in the Appendix, Table 34, and the main findings are presented and discussed in Chapter 8.

Household Consumption Functions for Rice, Oil, Fish, and Maize

In order to better understand how the scheme influenced the consumption of the principal food commodities, the calorie consumption function is complemented with consumption functions for each of the four principal food commodities—rice, oil, fish, and maize. The commodity functions are specified using the calorie consumption functions above, except that the prices of maize and fish are added. The coefficients estimated by these functions are shown in the Appendix, Table 35, and discussed in Chapter 8.

Calorie Consumption Functions for Preschoolers

To estimate the impact of the scheme on the consumption of calories by individual preschoolers, this model is used:

$$\begin{aligned}\mathrm{IC}_j = {} & b_0 + b_1\mathrm{LnAge}_j + b_2\mathrm{Sex}_j + b_3\mathrm{CBreastf}_j \\ & + b_4\mathrm{PBreastf}_j + b_5\mathrm{BirthO}_j + b_6\mathrm{EducH}_i \\ & + b_7\mathrm{EducS}_i + b_8\mathrm{ChTime}_j + b_9\mathrm{HHsize}_i \\ & + b_{10}\mathrm{Perchd6}_i + b_{11}\mathrm{Diarrhea}_j \\ & + b_{12}\mathrm{Water}_i + b_{13}\mathrm{Nutrelv}_i \\ & + b_{14}\mathrm{Nutredc}_i + b_{15}\mathrm{Foodasst}_i + b_{16}L_{2i} \\ & + b_{17}L_{3i} + b_{18}\mathrm{PwomenY}_i \\ & + b_{19}\mathrm{Ln}(Y_i/\mathrm{AEU}) + b_{20}S_i + b_{21}\mathrm{Price}_i \\ & + b_{22}\mathrm{Poil}_i + b_{23}\mathrm{Fever}_j + U_i, \qquad (4)\end{aligned}$$

where

IC_j = daily calorie consumption by preschooler j,

LnAge_j = log of the age of preschooler j,

Sex_j = sex of preschooler j (1 if male),

$\mathrm{CBreastf}_j$ = zero-one dummy (1 if the preschooler is currently breast-fed),

$\mathrm{PBreastf}_j$ = zero-one dummy (1 if the child was breast-fed in the past),

BirthO_j = birth order of preschooler j,

ChTime_j = time spent in child care by the mother of preschooler j,

$\mathrm{Perchd6}_i$ = proportion of children with age less than six years in household i,

$\mathrm{Diarrhea}_j$ = zero-one dummy (1 if the preschooler had diarrhea in the past week),

Water_i = zero-one dummy (1 if the household where preschooler belongs has sanitary potable water facility), and

---

[12] The price indexes were taken from Philippines, National Economic and Development Authority, *Philippine Statistical Yearbook* (Manila: NEDA, 1985).

Fever_j = zero-one dummy (1 if the preschooler had fever during the past week).

Other terms have already been defined.

The dependent variable in the equation is the calorie content of foods consumed by individual children between the ages of 13 and 83 months. Children less than 13 months of age are excluded from the analysis because breast-feeding of that age group is widespread and the calorie content of breast milk consumed was not estimated.

The pilot scheme's net effect on individual children is hypothesized to come from increases in overall incomes, nutrition education, and from the effects of the subsidy scheme itself. A semilog functional form is chosen to express the relationship between income and individual child consumption. A variant of this model is also tested using household calorie acquisition in place of household incomes. The inclusion of individual child variables such as age, sex, morbidity, birth order, and breast-feeding serve to control for child-specific variations and biological factors, whereas other household variables, such as the parent's education, household size and composition, women's incomes, child care time, rice and oil prices, and geographical location, are included in order to account for household differences that could influence individual calorie consumption of children. The demand equations are estimated by ordinary least squares for the 589 sample preschool children aged 13 to 83 months. Results of the regressions are given in the Appendix, Table 36, and the key findings are presented and discussed in Chapter 8.

Anthropometric Functions for Preschoolers

The effects of the scheme on the growth of preschoolers are estimated on the basis of estimating equations of the following general form:

$$W_j = f(Y_i, S_i, P_{rice}, P_{oil}, C_j, NE_i, Z_{i,j}), \quad (5)$$

where

W_j = an anthropometric indicator of the nutritional status of preschooler j,

Y_i = total income per capita of the household to which the preschooler belongs (i),

S_i = an indicator for the food subsidy,

C_j = calorie consumption by the household to which the preschooler belongs (used only as an alternative to Y_i),

NE_i = an indicator for whether the household received nutrition education from the scheme, and

$Z_{i,j}$ = a set of other variables hypothesized to influence W_j. All Z-variables are identical to those specified in the calorie consumption function for preschoolers.

The dependent variable is specified in five alternative ways: (1) weight of the preschooler, (2) weight as a percent of the standard weight for a particular age, (3) a standardized Z-score for weight-for-age, (4) a standardized Z-score of weight-for-height, and (5) the height as a percent of the standard height for a particular age. Z-scores are a method used to standardize a distribution. International standards are used in estimating the Z-scores because they facilitate comparison with other studies. The Z-scores for weight variables are defined as:

$$Z_{WA} = (W - W^*)/\text{s.d.} \quad (6)$$

where

W = actual weight of the child,

W^* = standard weight for a child of a particular sex and age, that is, the median of the reference population, and

s.d. = standard deviation from the standard for a particular sex and age.

Weight-related measures are expected to be more appropriate than height-related measures for analyses of effects on child growth in the short run. Thus, for the period of time involved in this study, the scheme is less likely to have an effect on height.

Cost-Effectiveness Analysis

For estimating the cost-effectiveness of the scheme, three sources of cost are identified: the cost of administration, the cost of the subsidy or price discount (the price discount per unit of rice and cooking oil times the quantity for which the discount was given), and the cost of the subsidized food paid by the participating households. The first two are borne by the public sector and referred to as "fiscal costs," whereas the last refers to the amount consumers pay for the subsidized commodities. The last two add up to the value of the subsidized commodities at nonsubsidized prices. The cost of the subsidy equals the subsidy benefits to the consumer because all costs of the scheme other than the price subsidy times the quantity subsidized are included under cost of administration.[13] The transaction costs incurred by participants are assumed to be identical to those they would incur with the purchase of nonsubsidized rice and oil. The transaction costs associated with participation in the nutrition education program, including the value of the time spent by the participants, are ignored in the cost estimations.

Effectiveness is measured, first, by the amounts of real income and calories transferred to the participating households including those households with either severe calorie deficits or children weighing less than 75 percent of standard, and, second, by the change in the nutritional status of children.

Table 5 provides an overview of the various measures used to estimate cost-effectiveness. These measures represent different indicators of benefits, such as changes in household incomes and food acquisition, food consumption by preschoolers, and the weight of preschoolers. They also represent five different target groups: all households in the target villages, only households with calorie consumption below 80 percent of requirements, only households with malnourished preschoolers, only preschoolers, and only malnourished preschoolers.

Thus, if the goal of the scheme is to reduce malnutrition among preschoolers, the measures reflect different degrees of leakage. Three sources of leakages are considered. The first source is households participating in the scheme that are not deficient in calories or that do not have preschoolers. The second is substitution between food and nonfood items and among foods resulting in a net increase in household food expenditures and calorie consumption that is smaller than the equivalent real income transfer. The third is when some of the net increase in household calorie consumption is consumed by household members other than preschoolers.

The fiscal cost of transferring one U.S. dollar of real income to all participating households is a crude indicator of cost-effectiveness from a nutrition point of view because all three sources of leakages are present. However, it may be an appropriate indicator if the goal is to transfer purchasing power at a low fiscal cost. One source of leakage is removed if only transfers to calorie-deficient households or households with malnourished preschoolers are considered (Table 5).

The second source of leakage—reduction in food acquisition from sources other than the subsidy—may be deleted from the cost-effectiveness measure by considering the cost of a net increase in household calorie consumption. The third source of leakage is deleted in the indicators that only deal with the effects on malnourished preschoolers.

In specifying the estimation procedures for each of the indicators, an estimate is made of the fiscal cost of transferring U.S. $1.00 of real income, first, to all participating households (H_1),

---

[13] Shlomo Reutlinger and Judith Katona-Apte, *The Nutritional Impact of Food Aid: Criteria for the Selection of Cost-Effective Foods,* Discussion Paper WB-ARU Report No. 12 (Washington, D.C.: World Bank, 1984).

Table 5—Overview of the cost-effectiveness measures used in this study

Fiscal Cost	All Participating Households (H_1)	Households Consuming Less than 80 Percent of RDA (H_2)	Households With Malnourished Preschoolers[a] (H_3)	All Preschool Children (C_1)	Preschool Children Consuming Less Than 80 Percent of RDA (C_2)	Malnourished Preschoolers[a] (C_3)
Fiscal cost of transferring U.S. $1.00	x	x	x			
Fiscal cost of a net increase in food acquisition of 100 calories per AEU per day	x	x	x			
Fiscal cost of eliminating the calorie gap	x	x	x			
Fiscal cost of a net increase in food consumption of 100 calories per preschooler per day				x	x	x
Fiscal cost of increasing the average weight of preschoolers by 1 kilogram				x	x	x

[a] Malnourished preschoolers are those with weight-for-age below 75 percent of standard.

$$(C_A + C_S)/C_S, \qquad (7)$$

where C_A is the cost of administration of the scheme, and C_S is the cost of the subsidy (price discount × total quantity of subsidized commodities). This is equal to the value of the subsidy received by all participating households.

Second, the cost of transferring U.S. $1.00 to households with a calorie deficit in excess of 20 percent of requirements (H_2) is estimated:

$$(C_A + C_S)/C_{S80}, \qquad (8)$$

where C_{S80} is the value of the subsidy received by households with a calorie deficit in excess of 20 percent of requirements.

Finally, the cost of transferring U.S. $1.00 to households with at least one preschooler whose weight-for-age is below 75 percent of the standard (H_3) is estimated:

$$(C_A + C_S)/C_{SMC}, \qquad (9)$$

where C_{SMC} is the value of the subsidy received by households with at least one preschooler whose weight-for-age is below 75 percent of standard.

The next step is to estimate the fiscal cost of increasing net household calorie acquisition by 100 calories per AEU per day among households in groups H_1, H_2, and H_3. The cost is given by $C_A + C_S$. The impact on calorie acquisition is estimated from the calorie acquisition function (3):

$$\begin{aligned}&[\partial(C/AEU)/\ln(Y/AEU)]\,VS\\&+ [\partial(C/AEU)/S]\,S + b_7\\&+ [\partial(C/AEU)/P_{oil}]\,\Delta P_{oil}, \qquad (10)\end{aligned}$$

where

VS = value of the subsidy, and
ΔP_{oil} = change in P_{oil} due to subsidy, and
b_7 = coefficient for nutrition education from the pilot scheme.

Thus, the fiscal cost of increasing the net household calorie acquisition by 100 calories per AEU per day is given by $(C_A + C_S)100$, divided by equation (10) above.

Now, the fiscal cost of increasing the net calorie consumption of preschoolers by 100 calories per AEU per day among groups of C_1 (all preschoolers), C_2 (preschoolers consuming less than 80 percent RDA), and C_3 (malnourished preschoolers) is estimated. The cost is as shown above. The impact is estimated from the calorie consumption function for preschoolers, equation (4), as

$$[\partial(IC)/\ln(Y/AEU)]\,VS + [\partial(IC)/S]\,S + b_{13} + [\partial(IC)/P_{oil}]\,\Delta P_{oil}. \quad (11)$$

The equation is evaluated at the mean for each of the three groups.

Finally, the fiscal cost of increasing the weight of preschoolers is shown above. The impact is estimated from equation (5),

$$[\partial(w)/\ln(Y/AEU)]\,VS + [\partial(w)/S]S + [\partial(w)/\partial(NE)]\,NE + [\partial(w)/P_{oil}]\Delta P_{oil}. \quad (12)$$

Data Collected and Survey Characteristics

The analytical framework discussed in this chapter was the basis for choosing the data that were collected in the study.

A stratified random survey of households in the pilot areas was conducted as a component of the project. A random sample of households was drawn from each of the eight subsidized and six nonsubsidized villages for a total sample of 840 households. These households were visited four times during the period between May 1983 and November 1984. Between the first and fourth survey round, 88 households dropped out of the survey. As stated earlier, the first survey was conducted two months prior to the introduction of the food subsidy. This survey provided the baseline information for the scheme. Within two months from the start of the scheme, the second survey was conducted using the same questionnaire as in the first survey. Exactly 12 months after the first survey, a third survey round was conducted. Thus, the first and third surveys were conducted in similar months of the first and second year in order to eliminate possible seasonal effects on income, production, consumption, and nutrition.

The subsidy scheme was in effect for a period of 12 months—July 1983 to June 1984. Two months after the withdrawal of the subsidies, the fourth survey was conducted. One of the purposes of the fourth survey was to understand how household consumption behavior was affected by the withdrawal of the subsidy.

Data were collected for all variables shown in Figure 4. Several modules were included. The first was a socioeconomic survey, including income of each household member; household expenditures on food and nonfood items; size, age, sex, occupation, and education of all household members; time allocated separately by the wife and husband to various activities; a series of questions on household decisionmaking, such as who within the household decides on expenditure patterns and purchases of specific items; environmental sanitation, including toilet and water facilities; and household participation in local government programs.

The second module was a consumption and food acquisition survey including household food consumption; household food acquired from purchases, own production, gifts, and wages; expenditures and prices of food; and only for a subsample of households, food intake by each household member.

Two dietary survey methods were used in the same questionnaire: the 24-hour food weighing method (here called food consumption) and the flexible period recall method (here referred to as food acquisition). The 24-hour food-weighing method was used in both the household and individual food-weighing surveys. Under this method, all items used in food preparation were weighed and so were leftovers. Snacks or foods eaten between meals were also taken into consideration. For the subsample where individual food intake was weighed, interviewers were present at the meal table.

Care was taken not to disrupt eating behavior during meals. Data collection was carried out by trained nutritionists and home economists, all females with at least a bachelor's degree, whose average work experience was six years. The interviewers came from the same provinces where the surveys were conducted in order to overcome language barriers. All interviewers underwent a week of extensive theoretical and field training on the procedures in order to minimize disruptions at mealtimes. For the other households where individual intakes were not taken, foods were weighed prior to cooking, just before the morning meals, and after dinner, when leftovers were weighed.

In the flexible period food recall method, the respondent mothers were asked to recall food expenditures (quantity, unit value, and monetary values) for the immediate past—a day, a week, or a month—which included all foods purchased from the market, foods from their own production either from home gardens or farms, and foods received as gifts or wages. The recall period was made on the basis of the normal frequency of purchase stated by respondent households.

The third module was the anthropometric data collected monthly throughout the study period to determine the health status of preschool children, including weight, height, age, and morbidity of each child less than seven years of age.

6

DESCRIPTIVE ANALYSIS OF INCOME, CONSUMPTION, AND NUTRITIONAL PATTERNS

In this chapter the results of the surveys for the five indicators are disaggregated by province, survey round, occupational group, and income quartile and analyzed to identify differences among population groups that may be useful for targeting of future subsidy programs or other interventions. A secondary but important objective is to gain knowledge about the survey households and individuals over and above what can be learned from the analyses based on the total sample.

Household Income Sources

The overall average monthly income of the sample households during the survey period was P 140 per capita (equivalent to a household income of P 910 per month) as compared to total expenditures of P 117 (Table 6). Some households in the poorest quartile spent slightly more than they earned. This occurred primarily among landless farm workers and tenant farmers other than those producing rice and maize, the two groups that were clearly the poorest of the sample. For the sample as a whole, incomes were considerably higher than expenditures during 1983, but these apparent savings did not continue in 1984, which probably reflects the rapid increase in prices during late 1983 and early 1984. About one-half of all incomes came from salaries and wages and about one-third originated in agriculture and fishing.

Food Acquisition and Consumption Patterns

Household consumption expenditures are used in this study as a proxy for income because consumption expenditure is hypothesized to be a better indicator of permanent income and hence a more important determinant of consumption behavior.[14] Consumption expenditures are also easier to measure, and nonsampling errors for this variable are likely to be much lower than those for incomes, which have been chronically understated in many household surveys.

The average share spent on major consumption items is shown in Table 7. On the average, 71 percent of total household expenditures went to food. This figure was much higher than the national average of 57 percent, which indicates that conditions in the study areas were relatively poorer.

The share spent on food fell as incomes rose in concurrence with Engelian relationships. While the households in the lowest income quartile allocated 79 percent of their total expenditures to food, those in the highest quartile allocated 63 percent. The share of income spent on food increased over time, which may be explained by the higher rate of inflation for rice than for other major budget items between 1983 and 1984. In early 1984, the ceiling price of rice was allowed to increase by about 45 percent over the previous year. Rice accounted for about 39 percent of the total food budget and nearly 26 percent of total household expenditures. Thus, rice prices were important in overall purchasing power.

Table 7 summarizes the budget shares of major expenditure items by province, season (survey round), occupation, and income group. The shares spent on nonfood items increased as incomes rose, particularly clothing and footwear, education, medical services, and housing. Shares spent on food varied widely between farm and nonfarm households. These variations may reflect

---

[14] Milton Friedman, *A Theory of the Consumption Function* (Princeton: Princeton University Press, 1957).

Table 6—Average incomes and income sources by province, survey round, occupation, and income quartile

				Income Source			
Category	Number of Household Visits[a]	Income Per Capita Per Month[b]	Total Expenditure Per Capita Per Month	Salaries/ Wages	Farm/ Livestock/ Fishing	Business	Rent/ Interest/ Pensions/ Gifts
		(pesos)		(percent of total income)			
Entire sample	3,167	140	117	51.3	34.4	6.5	7.8
Province							
Abra	908	140	131	43.8	37.9	4.0	14.3
Antique	1,382	149	106	55.7	30.3	8.6	5.4
South Cotabato	877	125	120	50.9	39.4	4.6	5.1
Survey round							
May 1983	840	122	96	50.4	36.4	6.3	6.9
November 1983	799	129	75	47.0	39.0	6.1	7.9
May 1984	776	151	149	54.5	30.3	6.8	8.4
November 1984	752	159	153	53.5	31.9	6.6	8.0
Occupational categories							
Rice farmer landowner	200	148	131	21.8	66.4	4.1	7.7
Maize farmer landowner	222	135	128	12.6	74.8	4.6	8.0
Farmer, other crops	77	136	127	23.0	65.3	1.3	10.4
Tenant rice farmer	87	112	113	19.9	70.7	0.9	8.5
Tenant maize farmer	136	121	118	21.0	70.4	0.5	8.1
Tenant, other crops	50	90	103	17.1	69.0	1.8	12.1
Landless farm laborer	275	98	104	69.4	18.2	3.1	9.3
Wage earner	817	133	107	70.4	19.4	4.6	5.6
Professional/salaried	116	300	218	83.6	11.4	1.7	3.3
Fishermen, boat owners	384	110	105	13.2	77.6	4.2	5.0
Hired fishermen	39	142	94	80.8	14.0	1.7	3.5
Employed overseas	256	191	132	83.5	10.4	3.1	3.0
Occupation unclassified	508	152	123	33.7	28.1	20.6	17.6
Income group							
First quartile (lowest)	791	78	82	41.1	41.6	4.8	12.5
Second quartile	791	100	96	40.3	46.0	6.6	7.1
Third quartile	791	130	118	49.9	37.9	6.2	6.0
Fourth quartile	791	252	173	59.8	25.6	7.1	7.5

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

[a] "Household visits" is defined as the number of sample households times the number of interviews performed in each household.

[b] Income includes the value of own production consumed.

differences in income as well as the semisubsistence nature of farming. The professionals and salaried workers spent 60 percent on food compared to the poorer wage earners' 81 percent. Surprisingly, food producers, such as rice farmers and fishermen, tended to spend more on food than those who were employed. It is important to note, however, that the present definition of food expenditures covers not only cash food purchases from the market but also the imputed values of food consumed from the households' own food production and food received as gifts and wages.

Food Consumption by Source of Food

For the entire sample, nearly 80 percent of total food expenditures was accounted for by food purchases (including food consumed away from home), 15 percent by own production, 5 percent by gifts received, and a small proportion by foods received as wages. The province of South Cotabato spent more on food purchases and less on food from own production. Nearly one-fifth of Abra's food consumption came from production of their own rice and maize.

Table 7—Percent of total household expenditures on major commodity groups, by province, survey round, occupation, and income class, 1983-84

Category	Total Expenditures Per Capita	Food				Housing/ Fuel	Trans-portation	Medical Services/ Drugs	Edu-cation	Clothing and Footwear	Fiestas and Cere-monials	Durable Goods	Other Goods and Services
		Pur-chased Food	Own Prod-uce	Gifts/ Wages	Total Food								
	(pesos/month)							(percent)					
Entire sample	117	56.1	10.6	4.2	70.9	8.2	2.7	4.1	1.4	4.8	4.0	1.9	2.0
Province													
Abra	131	56.2	12.3	5.4	73.9	8.0	2.0	2.4	1.7	4.1	4.1	1.7	2.1
Antique	106	53.9	12.6	3.3	69.5	8.4	2.6	3.0	1.4	4.7	2.7	3.7	3.7
South Cotabato	120	60.4	6.9	3.7	71.0	8.2	3.6	5.0	1.2	3.9	3.2	2.6	1.3
Survey round													
May 1983	96	56.7	10.1	3.2	70.0	7.1	2.0	6.1	0.0	8.2	6.0	0.5	0.1
November 1983	75	52.1	10.2	3.4	65.7	8.3	2.1	2.3	1.5	7.9	6.5	2.3	3.4
May 1984	149	58.5	10.6	4.7	73.8	8.5	3.2	1.7	1.0	4.8	5.5	1.0	0.5
November 1984	153	55.1	12.6	4.3	72.0	8.8	3.3	2.9	1.8	6.1	1.2	3.3	0.6
Occupational categories													
Rice farmer landowner	131	46.2	19.5	4.1	69.8	7.1	1.9	6.0	1.5	7.6	4.3	0.7	1.1
Maize farmer landowner	128	52.3	10.5	3.9	66.7	8.3	2.0	7.1	1.2	7.1	5.4	1.0	1.2
Farmer, other crops	127	54.7	17.9	2.7	75.3	7.0	2.6	3.0	1.7	4.0	6.2	0.1	0.1
Tenant rice farmer	113	49.4	22.7	4.3	76.4	7.0	1.7	2.8	1.0	2.1	7.1	1.0	0.9
Tenant maize farmer	118	61.7	9.9	4.7	76.3	7.2	3.5	3.2	0.3	2.0	6.0	0.9	0.6
Tenant, other crops	103	59.5	18.1	4.1	81.7	7.4	2.9	1.9	0.5	1.1	4.3	0.1	0.1
Landless farm laborer	104	61.3	10.5	10.9	82.7	8.3	1.6	1.7	0.5	1.0	4.0	0.1	0.1
Wage earner	107	69.1	6.7	5.1	80.9	7.6	4.1	0.7	1.1	3.6	1.7	0.1	0.2
Professional/salaried	218	51.2	5.3	3.5	60.0	10.8	5.0	3.7	3.1	10.1	2.3	3.0	2.0
Fishermen, boat owners	105	58.3	20.9	3.7	82.9	5.5	3.7	2.1	1.0	3.0	1.0	0.2	0.6
Hired fishermen	94	60.9	8.1	7.8	76.8	8.3	2.1	3.2	0.9	2.0	4.7	1.0	1.0
Employed overseas	132	54.4	6.4	2.4	63.2	10.2	3.1	4.2	2.1	8.9	4.3	2.0	2.0
Occupation unclassified	123	51.5	8.7	3.1	63.3	10.0	3.0	4.1	1.7	8.8	4.1	3.0	2.0
Income group													
First quartile (lowest)	82	61.8	10.9	5.9	78.6	7.0	3.0	1.7	0.2	5.0	4.1	0.3	0.1
Second quartile	96	61.4	12.3	5.2	78.9	7.6	2.2	2.7	0.4	5.0	2.1	1.0	0.1
Third quartile	118	59.2	11.4	4.3	74.9	8.1	2.1	3.0	0.5	4.8	4.4	1.7	0.5
Fourth quartile	173	50.2	10.1	2.6	62.9	10.7	2.9	4.3	2.7	8.1	3.3	3.0	2.1

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

Between 1983 and 1984 the absolute percentage of subsistence consumption—food grown for the household's own consumption—increased, partly indicating the effects of the increase in food prices over the period.

The food acquisition pattern by sources of food varied by occupation. The shares of food consumption from own production, as expected, were highest among the food producers, such as the rice farmers and fishermen. However, even among rice farmers who owned land, about two-thirds of the total food consumed was accounted for by purchases from the market, while 19 percent came from own production and 4 percent was received as gifts. Similar consumption patterns among rural groups were observed by Trairatvorakul in Thailand.[15]

Among the farming groups, the survey indicates a larger proportion of subsistence consumption among rice farmers than maize farmers. This is because most of the people in the sample were rice eaters, and maize is used more as livestock feed than for human consumption in most parts of the Philippines. The landless farm laborers depended on market purchases for 61 percent of their household food expenditures.

It is estimated that 21 percent of the food consumed by the families of boat-owning fishermen came from their own production. Hired fishermen depended on the market for a higher proportion of their household food supply than did boat-owning fishermen. Food received as wages composed 8 percent of the total food consumed by hired fishermen, the second highest percentage of all occupational categories. This reflects the practice of paying hired workers from the day's catch of fish.

Although the samples were all drawn from rural areas, about 48 percent of the households had nonfarming, nonfishing occupations. The main sources of livelihood for the major breadwinners in many households were urban-based or urban-related, despite their rural residences. For these groups, 85 percent of all food consumed came from purchases. About 10 percent of their food supply came from their own production, mostly from backyard fruit and vegetable gardens.

Allocation of the Food Budget by Food Group

Table 8 gives the breakdown of the average household food budget allocated to each food group. There were 124 food groups coded in the survey, and these were aggregated into the 12 main food groups reported in Table 8. The last one is the residual from the first 11 and is designated as "other foods."

For the entire sample, rice accounted for nearly 40 percent of total food expenditures, fish for 18.6 percent, and vegetables and fruits for 11.3 percent.

A comparison of the patterns of food expenditure across provinces indicates that minor variations occurred in rice expenditures, but major differences were found in nonstaple foods. Although South Cotabato is a maize-producing province, its population is basically rice-eating. This explains its lower food expenditures for maize compared to Abra, where part of the population eats maize during certain periods of the year. Abra spent about 2.8 percent of its food expenses on maize, the highest among the three provinces. As expected, the share spent for fish was highest in the coastal province of Antique—23 percent compared to only 13 percent in Abra. Abra's fish supply came mostly from freshwater sources, mainly out of the Abra River. Abra spent more on poultry, fruits, and vegetables than the other two provinces. The other food groups did not vary much by province.

The major differences in the pattern of food expenditures observed were across occupational categories. Certain food items were heavily consumed by the producers themselves. Rice, maize, fruits, and vegetables, for example, were most heavily consumed by farmers, tenants, and farm laborers,

---

[15] Prasarn Trairatvorakul, *The Effects on Income Distribution and Nutrition of Alternative Rice Price Policies in Thailand,* Research Report 46 (Washington, D.C.: International Food Policy Research Institute, 1984).

Table 8—Proportion of the food budget allocated to various foods, by province, survey round, occupation, and income group, 1983-84

Category	Per Capita Food Expenditures[a]	Rice	Maize	Bread	Cooking Oil	Poultry	Fish	Pork and Beef	Fruits and Vegetables	Other Foods[b]
	(pesos/month)					(percent)				
Entire sample	78	39.5	1.0	1.5	2.2	4.9	18.6	5.0	11.3	16.0
Province										
Abra	86	37.7	2.8	0.8	1.8	8.4	13.2	5.5	13.1	16.1
Antique	76	37.5	0.1	2.9	2.4	2.1	22.9	3.4	10.9	16.4
South Cotabato	73	43.5	0.1	0.8	2.5	8.1	20.6	4.6	9.9	9.7
Survey round										
May 1983	58	42.3	0.1	1.8	1.9	4.6	21.5	5.8	14.1	7.9
November 1983	62	37.2	0.8	1.6	2.0	3.6	17.5	4.8	12.5	20.0
May 1984	96	36.4	0.3	2.1	2.8	3.8	17.3	2.9	10.9	23.5
November 1984	97	41.3	2.3	1.4	1.9	5.3	17.2	4.9	9.4	15.3
Occupational categories										
Rice farmer landowner	88	38.8	1.3	1.9	1.9	5.9	17.4	6.4	12.2	14.2
Maize farmer landowner	75	42.8	1.5	0.8	2.1	8.9	20.4	5.6	11.2	6.7
Farmer, other crops	85	40.8	0.9	0.5	2.6	4.3	17.3	2.4	15.2	16.0
Tenant rice farmer	81	39.1	1.8	0.6	1.8	1.4	11.9	4.5	14.3	24.6
Tenant maize farmer	78	41.8	0.2	1.3	2.2	8.4	18.1	4.0	11.1	12.9
Tenant, other crops	80	42.1	1.8	0.1	1.9	3.9	7.3	1.5	12.4	29.0
Landless farm laborer	68	45.3	1.4	0.5	1.9	3.8	15.8	1.7	9.9	19.7
Wage earner	74	40.7	0.9	1.8	2.2	4.3	18.5	4.3	10.7	16.6
Professional/salaried	122	25.2	0.3	2.8	3.2	5.1	19.7	9.6	9.8	24.3
Fishermen, boat owners	76	40.8	1.2	1.5	1.9	1.6	21.1	1.1	7.2	23.6
Hired fishermen	78	42.2	0.0	3.8	2.2	0.5	25.3	2.1	9.5	14.9
Employed overseas	84	33.7	0.9	2.8	2.5	3.7	20.5	6.3	9.8	19.8
Occupation unclassified	79	34.5	0.4	2.6	2.3	2.9	21.1	5.2	9.1	21.9
Income group										
First quartile (lowest)	55	46.2	1.1	1.3	1.9	3.2	17.9	4.2	12.1	12.1
Second quartile	82	43.1	1.3	1.3	1.8	3.9	17.1	3.1	11.6	16.8
Third quartile	113	39.8	0.9	1.1	2.2	5.4	18.2	2.8	9.8	17.1
Fourth quartile	213	33.1	0.7	2.6	2.5	4.4	18.7	6.7	10.1	21.2

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

[a] Per capita food expenditures include the value of food acquired from all sources: purchases, own produce, and foods given as gifts and as wages.

[b] Other foods include cassava, sweet potato, sugar, milk, eggs, and others.

and fish and fish products by the boat-owning fishermen and the hired fishermen. The diets of professionals and overseas workers varied more, as indicated by the smaller proportions spent on staples and the increasing percentage allocated to foods such as meat, milk, eggs, bread, and cooking oil. Within the farming groups, the landless farm laborers had the least varied diet, spending most of their food budget on rice and maize. In general, the composition of the food budget of land-owning farmers was more varied than that of the tenant farmers.

Population groups forming the lowest quartile spent larger proportions of their budgets on staples, such as rice, maize, sweet potatoes, and cassava, and smaller proportions on milk, eggs, meat, and cooking oil. From a high of 46 percent in the lowest income quartile, rice's share of the food budget declined to 33 percent in the highest quartile. Expenditure shares of bread, pork, beef, and cooking oil were largest in the highest income quartile. Shares spent on fish did not appear to vary by income group. This may be because the higher income quartiles in the sample were still at the lower end of the income distribution of the Philippines as a whole.

Food Consumption

In the food-weighing procedure used to estimate food consumption, all food served to household members was weighed before meals and the leftovers after for a given 24-hour period, and each of these foods was converted into calorie equivalents.

Daily calorie consumption, which is based on the 24-hour weighing method, is estimated at 1,701 calories per AEU for the entire sample. This is about 374 calories less than the standard recommended by FNRI.[16] Thus, it appears that the sample area as a whole was deficient in calories. Average measures, however, tend to mask the deficiency levels for particular population groups. For purposes of this analysis, the calorie consumption and adequacy of the sample population was disaggregated by location (province), survey round, occupational grouping, and income group.

Statistics summarized in Table 9, using information from the 24-hour food weighing survey, suggest that the people in South Cotabato were worse off than those in the other two provinces. It was the only province where calorie deficits averaged more than 400 calories per day. As shown in Table 6, South Cotabato had the lowest per capita incomes, indicating a likely relationship between undernutrition and economic deprivation.

Caloric intakes vary significantly even within subsectors of socioeconomic groups based on occupation. For instance, within the farming sector, it is clear that rice farmers who are landowners have higher caloric intakes than farmers growing maize or other crops. It is, however, incorrect to conclude that all rice producers are relatively well-fed. It is evident from the results that the smaller rice producers, like tenant rice farmers, have large calorie deficiencies, and the problem is even more pronounced among farm laborers working in the rice sector: their calorie deficits are the highest of all occupational groups. The significant differences in caloric intakes among the various occupational subcategories within rice farming support the theory that the rice-farming sector is not homogeneous; hence, analysis of policies affecting the sector should explore the distributional patterns within.

The disaggregation of the fishing sector into fishermen who own boats and hired fishermen indicates varying degrees of deficiency between these groups. The significant difference in their means amplifies the

---

[16] The Philippine standards for calories were based on the assumption that energy expenditures for Filipinos differ from those of other people because of differences in body size and type, as well as duration of physical activities, rather than because of intrinsic physiological differences. FNRI's energy expenditure and intake studies based on the Philippine population formed the basis for the calorie requirement standards used in this study. A summary of the standards for all sex, age, and physiological status categories can be found in Philippines, Food and Nutrition Research Institute, *Publication No. 75* (Manila: FNRI, May 1977).

Table 9—Diet composition by food groups, survey round, occupation, and income group, 1983-84

Category	Daily Calories Per AEU[a]	Rice	Maize	Bread	Sweet Potatos/ Cassava	Sugar	Cooking Oil	Poultry	Fish	Pork and Beef	Milk and Eggs	Fruits and Vegetables	Other Foods
		(percent of total calories consumed)											
Entire sample	1,701	76.1	2.8	1.7	0.7	1.9	2.9	1.9	3.0	1.5	1.5	3.0	3.0
Province													
Abra	1,755	74.1	7.1	1.0	0.5	2.3	2.1	1.6	1.7	1.3	1.6	3.2	3.5
Antique	1,720	75.3	0.7	2.1	1.3	1.7	3.2	1.7	5.9	1.5	0.6	3.1	2.9
South Cotabato	1,613	78.6	0.8	1.3	0.2	1.9	3.4	2.3	3.0	2.1	1.5	2.9	2.0
Survey round													
May 1983	1,715	77.5	1.0	1.0	0.3	0.2	2.7	1.1	4.5	2.0	1.0	2.9	5.8
November 1983	1,676	76.5	3.5	1.2	0.5	0.9	3.1	1.7	3.5	1.5	1.1	2.8	3.7
May 1984	1,735	79.0	2.0	2.1	1.0	1.5	3.6	1.9	3.5	1.0	1.5	2.0	0.9
November 1984	1,675	75.0	7.0	1.4	1.0	1.9	1.4	1.5	2.0	1.0	2.5	3.6	1.7
Occupational categories													
Rice farmer landowner	1,956	75.6	3.1	1.5	0.3	1.2	2.1	1.2	3.1	1.4	0.8	2.8	6.9
Maize farmer landowner	1,671	77.4	7.0	0.4	0.2	0.7	2.5	2.3	3.2	1.4	0.5	2.4	2.0
Farmer, other crops	1,767	77.0	2.5	0.5	0.1	1.1	3.0	1.2	2.9	1.1	0.4	3.2	7.0
Tenant rice farmer	1,692	77.2	4.6	0.3	0.3	0.7	2.1	3.3	2.2	1.6	0.2	2.4	5.1
Tenant maize farmer	1,659	79.4	0.7	1.1	0.2	0.6	2.7	2.2	2.9	1.4	0.4	2.6	5.5
Tenant other crops	1,718	80.2	5.3	0.1	0.1	0.6	2.2	0.1	1.4	0.4	0.3	2.5	6.8
Landless farm laborer	1,580	81.6	2.9	0.3	0.1	0.7	1.9	1.0	2.7	0.6	0.4	2.3	5.5
Wage earner	1,668	82.2	2.6	1.1	0.1	0.9	2.3	1.0	3.7	1.1	0.5	2.7	1.8
Professional/salaried	1,899	66.9	0.9	2.1	0.3	1.8	4.9	1.6	4.5	3.5	1.5	3.1	8.9
Fishermen, boat owners	1,721	80.7	2.3	1.1	0.5	0.7	2.5	0.5	7.5	0.2	0.3	2.4	1.3
Hired fishermen	1,692	79.7	0.0	2.5	0.1	1.4	2.0	0.0	7.1	0.6	0.5	4.3	1.8
Employed overseas	1,634	74.2	1.8	1.6	0.2	1.6	3.3	0.8	4.3	1.5	0.9	3.1	6.7
Occupation unclassified	1,691	81.8	0.6	1.5	0.3	0.8	2.8	1.1	4.0	1.4	0.4	2.7	1.8
Income group													
First quartile (lowest)	1,627	79.1	2.9	0.2	1.3	0.5	1.9	1.4	3.9	1.0	0.5	3.2	4.1
Second quartile	1,709	78.0	1.9	0.3	0.9	1.2	2.7	1.5	3.7	1.1	0.6	3.1	5.0
Third quartile	1,696	77.1	1.0	1.9	0.2	1.8	3.2	2.3	3.4	1.9	1.8	2.7	2.7
Fourth quartile	1,771	72.6	0.5	2.9	0.1	2.9	4.0	2.5	3.6	2.9	3.0	2.7	2.3

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

[a] Daily calories per adult equivalent unit were based on 24-hour food weighing.

need to look at the patterns within population groups in order to understand the impact of particular policies. Among the nonfarming occupational groups, wage earners were particularly deficient in calories, while, as expected, the professionals and salaried workers had the lowest average deficits.

Diet Composition

A disaggregation of the sources of calories for the sample households illustrates the overwhelming dominance of rice in the diet, accounting for more than three-fourths of total calories. The dependence on rice holds true in all areas, in practically all seasons, for all occupational categories, and for all income groups. The overall dependence on one staple commodity also implies that, in general, there is little diversity in the diet.

The composition of the average diet varied slightly among the three provinces. Abra showed the least dependence on rice, but its consumption of maize was much higher than that of the other two provinces because maize is eaten in Abra during the lean months. The coastal province of Antique derived the highest proportion of its calories (and protein) from fish.

Meal patterns of a typical household in the sample consisted of staples such as rice (326 grams per capita daily), dried or fresh fish, *bagoong* or fish sauce, leafy vegetables such as *kangkong, malunggay, talong,* and mung beans, and fruit. As mentioned before, in areas where maize is grown, maize supplements rice as a staple, which is eaten as a rice-maize mix. Bread is eaten in the form of a roll made of wheat flour called *pan-de-sal,* which is usually eaten for breakfast. Pork, poultry, and beef are part of the meal only on occasion.

Household Calorie Acquisition

As shown in Table 10, average calorie acquisition for the sample as a whole, based on the flexible recall period (one week or one month), exceeded calorie consumption by 136 calories per AEU per day, or 7 percent. As mentioned earlier, there are several reasons for this slight divergence. First, because no food weighing was done on Saturdays and Sundays, food consumption estimates refer to an average daily consumption for the week based on actual consumption for only five days, Monday to Friday, whereas food acquisition covered all seven days of the week. Moreover, Philippine households usually consume more food during the weekend. Second, part of the difference may also be explained by the failure to take into account wastage in the estimates based on food acquisition.

Although it is not possible to determine the bias of each of the two estimates, and thus the "true" value, it may be hypothesized that the two estimates provide a lower and upper bound. It is also likely that the estimate based on acquisition is closer to the true value because it reflects consumption during all days of the week and because the method itself is unlikely to influence actual consumption.

There was also a slight seasonal variation in the composition of the diets in the sample. The relative importance of rice declined slightly during the lean month of November, compared to May, due to the increase in consumption of maize in Abra. A large proportion of Abra's population eats rice mixed with maize grits on a 60-40 or 70-30 ratio during the maize harvest months from August to November.

Tenant farmers of cash crops, landless farm laborers, and fishermen had the least diverse diets, while the most diverse were, as expected, those of the professionals and salaried workers, the households of workers employed overseas, and the landowning rice farmers. Professionals depended less on cereals for their caloric needs and obtained a relatively higher proportion from such foods as bread, cooking oil, milk, meat, and eggs. The opposite was true for the low-income occupational groups, such as the landless farm laborers, who depended on rice for 82 percent of total caloric intakes.

Table 9 indicates the increasing diversification in the average diet as income increases. This is marked by the decreasing but still significant role of rice and maize in

Table 10—Calorie acquisition by food groups, survey round, occupation, and income group, 1983-84

Category	Daily Calorie Acquisition Per AEU	Rice	Maize	Bread	Sweet Potatos/ Cassava	Sugar	Cooking Oil	Poultry	Fish	Pork and Beef	Milk and Eggs	Fruits and Vegetables	Other Foods
							(percent of total calories acquired)						
Entire sample	1,837	62.7	5.7	1.7	1.6	3.7	3.1	2.0	3.6	1.1	1.8	5.6	7.4
Province													
Abra	1,818	55.4	16.2	1.5	2.2	3.1	2.8	1.7	0.9	1.2	1.3	6.0	7.7
Antique	1,915	65.8	1.1	1.9	0.9	4.0	3.3	1.8	6.5	0.8	1.7	4.7	7.5
South Cotabato	1,736	66.0	1.1	1.8	2.0	3.8	3.2	2.7	2.0	1.6	2.3	6.5	7.0
Survey round													
May 1983	1,777	64.4	1.6	2.2	1.9	4.6	3.4	[illegible]	4.4	1.5	2.0	5.0	7.4
November 1983	1,903	62.5	6.2	2.2	0.8	3.4	4.3	[illegible]	3.4	1.2	2.5	4.7	7.2
May 1984	1,911	63.6	2.6	1.4	2.3	3.5	3.6	2.[illegible]	3.5	1.0	1.5	7.1	7.7
November 1984	1,756	60.1	12.7	1.3	1.3	3.2	1.2	2.6	2.9	0.8	0.9	5.6	7.4
Occupational categories													
Rice farmer landowner	2,012	59.4	10.5	1.5	1.8	3.5	2.6	2.3	2.5	1.1	1.4	6.0	7.4
Maize farmer landowner	1,776	62.6	5.0	1.5	1.7	3.5	2.6	2.9	1.8	1.7	2.5	6.6	7.6
Farmer, other crops	1,899	65.4	2.9	1.7	0.9	3.5	4.2	2.9	2.1	1.3	1.4	5.8	7.7
Tenant rice farmer	1,914	55.7	14.8	1.3	1.7	3.0	2.6	2.7	1.2	1.2	1.7	6.8	7.3
Tenant maize farmer	1,849	62.5	3.4	1.6	2.2	3.7	3.4	2.6	1.9	1.3	1.7	7.7	8.0
Tenant other crops	1,857	57.3	12.0	1.3	2.4	3.2	3.0	1.9	1.3	1.2	0.7	6.3	9.4
Landless farm laborer	1,655	62.7	8.9	1.4	2.2	3.0	2.7	1.9	1.8	1.1	2.1	4.7	7.5
Wage earner	1,767	64.6	5.7	1.7	1.6	3.9	3.0	1.8	2.7	1.0	1.1	5.0	7.9
Professional/salaried	2,184	56.4	3.6	2.8	1.4	5.1	3.9	2.5	2.9	2.7	2.7	8.8	7.2
Fishermen, boat owners	1,926	62.1	4.2	1.6	1.1	2.8	3.1	1.7	10.1	0.5	1.0	4.7	7.1
Hired fishermen	1,877	68.1	0.3	1.8	0.7	3.3	6.5	1.5	8.5	0.7	1.1	3.1	4.4
Employed overseas	1,795	62.3	4.7	2.4	1.6	4.6	3.4	1.7	2.4	1.3	2.3	5.9	7.4
Occupation unclassified	1,849	63.9	4.5	1.9	1.7	4.0	3.4	1.9	2.6	1.2	1.8	6.0	7.1
Income group													
First quartile (lowest)	1,696	64.5	5.0	1.6	1.3	3.4	3.1	1.7	3.9	0.9	1.9	5.0	7.7
Second quartile	1,831	62.8	6.6	1.6	1.7	3.4	3.0	1.9	4.0	0.9	1.5	5.2	7.4
Third quartile	1,852	62.3	5.3	1.8	1.8	3.7	3.2	2.2	3.3	1.2	1.6	5.7	7.9
Fourth quartile	1,970	61.0	5.8	2.0	1.5	4.3	3.3	2.2	2.9	1.6	2.0	6.6	6.8

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

overall food consumption and the increasing relative importance of such calorie sources as bread, cooking oil, sugar, beef, pork, poultry, milk, and eggs. Although the poorest income group, as expected, derived the highest proportion of total calories from rice and maize, their diet was surprisingly high in fish, fruits, and vegetables. One possible explanation is that the lowest income group receives a relatively higher proportion of their nonstaple foods as wages (such as fish) or as gifts from neighbors (backyard produce of fruits and vegetables).

The share of calories from cooking oil for the highest income quartile was almost twice that of the lowest income group. The same trend can be observed for milk, eggs, pork, beef, and bread.

It appears that the 24-hour food weighing method overestimated the consumption of rice and underestimated the consumption of virtually all other commodities. This pattern was consistent for all population groups. As a consequence, the relative importance of rice in the diet is much lower if food acquisition data are used.

The difference between food acquisition and food consumption data is large for sugar, fruits and vegetables, and other foods.[17] It is conceivable that these commodities played a more important role in weekend meals and therefore were underrepresented in the 24-hour weighing. Or, sugar used in food preparation and in coffee may not have been fully accounted for in the food weighing, which focused on the main meals. Finally, fruits and vegetables consumed between meals may not have been fully reflected in the food weighing.

Maize acquired under flexible period recall is reported to be more than twice the amount of maize consumed under 24-hour weighing. This difference can be traced almost totally to maize in Abra, which was estimated to be 125 calories per AEU per day using the weighing method and 318 calories per AEU per day using recall. There is no obvious explanation for this difference.

Individual Calorie Intake and Adequacy

For a subsample composed of 140 households, individual food consumption data were collected, using a combination of techniques. Food weighing and observation techniques were used in determining intrafamilial distribution of food, while the recall method was used in determining food consumed outside the home. Data were collected for every member of the household over a 24-hour period, and the survey was repeated for the same households and members four times during the study period.

To assess whether a person consumed an amount more, less, or equal to the average calorie requirement, the study compares the calories consumed with the Philippine RDA for calories.[18] Table 11 provides data on calorie intake and calorie adequacy ratios (intake divided by require ments) by sex and age group for each of the four population quartiles. The mean calorie intake of preschool children was far below requirements, particularly for females, who obtained only 50 to 55 percent of their requirements. Male preschool children, although better off than their female counterparts, still consumed much less than the norm. The difference between adequacy rates for male and female preschoolers is statistically significant at the 5 percent level.

The calorie adequacy of adults above 18 years of age was higher than that for children and adolescents. There was no significant difference between the husbands' and wives' calorie adequacy, except when the wives were pregnant or lactating. Women who were pregnant or lactating at the time of the survey had adequacy ratios of 0.69 compared to 0.78 for all wives and

---

[17] Such differences were also found in Egypt. See Harold Alderman and Joachim von Braun, *The Effects of the Egyptian Food Ration and Subsidy System on Income Distribution and Consumption,* Research Report 45 (Washington, D.C.: International Food Policy Research Institute, 1984).

[18] Philippines, National Nutrition Council, Nutrition Research Committee, *Philippine Recommended Dietary Allowances, Part I, Nutrients* (Manila: National Nutrition Council, 1976).

Table 11—Calorie intakes of groups of individual household members

Gender	Age	First Income Quartile			Second Income Quartile			Third Income Quartile		
		Daily Calorie Intake	Calorie Adequacy	Number of Observations[a]	Daily Calorie Intake	Calorie Adequacy	Number of Observations[a]	Daily Calorie Intake	Calorie Adequacy	Number of Observations[a]
	(years)		(percent)			(percent)			(percent)	
Male	1 – 6	873	0.59	115	877	0.61	89	817	0.59	114
Male	7 – 12	1,221	0.65	27	1,355	0.70	39	1,364	0.70	74
Male	13 – 18	1,675	0.67	16	1,520	0.60	29	1,356	0.53	28
Male	19 – 39	1,906	0.74	109	2,055	0.80	91	1,942	0.75	122
Male	40 – 64	1,986	0.83	19	2,074	0.86	23	2,118	0.89	33
Male	65 and older	1,914	0.97	5	968	0.52	3	2,251	1.14	6
Female	1 – 6	711	0.52	128	797	0.56	104	818	0.55	140
Female	7 – 12	1,114	0.58	52	1,197	0.62	71	1,171	0.61	81
Female	13 – 18	1,263	0.58	11	1,353	0.62	20	1,189	0.60	26
Female	19 – 39	1,607	0.73	123	1,648	0.76	100	1,581	0.75	141
Female	40 – 64	1,438	0.78	28	1,519	0.88	26	1,618	0.93	41
Female	65 and older	1,235	0.90	10	1,270	0.90	15	1,582	1.09	6
Male (household head)		1,955	0.77	116	2,117	0.84	98	2,032	0.81	130
Female (spouse)		1,591	0.73	134	1,598	0.76	110	1,625	0.80	143
Pregnant or lactating women		1,606	0.68	90	1,704	0.72	59	1,589	0.68	69

Gender	Age	Fourth Income Quartile			Total for Entire Sample		
		Daily Calorie Intake	Calorie Adequacy	Number of Observations[a]	Daily Calorie Intake	Calorie Adequacy	Number of Observations[a]
	(years)		(percent)			(percent)	
Male	1 – 6	902	0.63	125	868	0.60	443
Male	7 – 12	1,368	0.69	97	1,348	0.69	237
Male	13 – 18	1,374	0.55	32	1,455	0.58	105
Male	19 – 39	1,880	0.73	88	1,944	0.75	410
Male	40 – 64	1,969	0.82	41	2,035	0.85	116
Male	65 and older	1,717	0.88	11	1,795	0.92	25

(continued)

Table 11—Continued

Female	1-6	858	0.59	111	794	0.55	483
Female	7-12	1,197	0.64	65	1,173	0.61	269
Female	13-18	1,350	0.63	37	1,324	0.61	94
Female	19-39	1,682	0.81	132	1,628	0.76	496
Female	40-64	1,364	0.76	39	1,487	0.84	134
Female	65 and older	1,577	1.11	12	1,377	0.98	43
Male (household head)		2,020	0.80	101	2,028	0.80	445
Female (spouse)		1,691	0.83	135	2,152	0.78	522
Pregnant lactating women		1,737	0.72	47	1,646	0.69	265

Source: Based on data collected by the International Food Policy Research Institute. Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

Note: These are data from the four survey rounds combined.

[a] The number of observations is the number of persons times the number of interviews of each person.

0.80 for husbands. Again, the calorie adequacy rate tended to rise as household income increased for most groups. The patterns observed in this study essentially conform to those observed in other regions in the Philippines.[19]

These findings suggest that in order to reach nutritionally vulnerable household members, targeting households with malnourished preschoolers may be inadequate. School-age children and adolescents, particularly females, were as deficient in calories as preschoolers.

Nutritional Status of Preschool Children

Anthropometric data for all preschool children in the sample households provide the basis for determining their nutritional well-being relative to a particular growth standard. Four indicators of nutritional status are reported in Table 12: mean weight as a percent of standard, proportion of children below 75 percent of standard weight-for-age, proportion below 60 percent, and Z-scores of weight-for-age. Although a local Philippine weight standard is available, this portion of the study uses international standards developed by the National Center for Health Statistics of the United States in order to facilitate international comparisons of results.

Results reveal that one of every four children in the study areas is malnourished to either the second or third degree (less than the 75 percent cutoff suggested in the Gomez classification system). Malnutrition appears to have been higher in the province of Antique than in the two other sample provinces. The data suggest that malnutrition declined dramatically from 34 to 18 percent during the 17 months between the first and last survey round. The improvement in child weight relative to the standard is also reflected in the mean weight-for-age, which increased from 80.7 to 85.0 percent. The Z-scores for weight-for-age are also consistent with nutritional improvement during the period.

The incidence of child malnutrition varied according to the occupational group of the parents. The highest percentage of malnourished children belonged to families of hired fishermen (40 percent), boat-owning fishermen (30 percent), tenant farmers of nonfood crops (28 percent), maize farmers (24 percent), wage earners (23 percent), and landless farm laborers (22 percent). The groups that were relatively well off were the children of professionals and salaried workers and landowning rice farmers—the occupational groups with the highest incomes (see Table 6). These results indicate that income and sources of income are factors that account for differences in nutritional status across occupational groups. The analysis of nutritional level by income group also bears out this observation. It shows that 15.9 percent of children in the highest income quartile were malnourished, compared with 29.8 percent of children belonging to the lowest income quartile. Z-scores of weight-for-age and mean weight-for-age show similar improvements as income increases.

---

[19] Robert E. Evenson, Barry M. Popkin, and Elizabeth K. Quizon, "Nutrition, Work and Demographic Behavior in Rural Philippine Households," in *Rural Households in Asia*, ed. Hans B. Binswanger et al. (Singapore: Singapore University Press, 1980); Melba B. Aligaen and Cecilia A. Florencio, "Intra-Household Nutrient Distribution and Adequacy of Food and Nutrient Intake of Filipino Urban Households," *Philippine Journal of Nutrition* (January-March 1980): 11-19; and Rosario Valenzuela, "A Study on Nutrient Distribution within the Family and Factors Affecting Nutrient Intake," University of the Philippines, Diliman, 1977 (mimeographed).

Table 12—Nutritional status of preschool children, 1983-84

Category	Number of Observations	Mean Weight as a Percent of Standard Weight-for-Age	Mean Z-Scores of Weight-for-Age	Percentage of Malnourished Children: Second Degree[a]	Percentage of Malnourished Children: Third Degree[b]
		(percent)		(percent)	
Entire sample[c]	3,053	83.12	−1.64	23.16	1.84
Province[c]					
Abra	803	83.85	−1.58	20.33	1.00
Antique	1,336	82.71	−1.71	26.24	1.81
South Cotabato	914	83.09	−1.60	20.85	2.65
Survey round					
May 1983	768	80.74	−1.87	29.88	4.42
November 1983	766	83.18	−1.66	24.40	1.36
May 1984	770	83.90	−1.57	20.99	0.53
November 1984	749	85.03	−1.47	16.82	0.90
Occupational categories[c]					
Rice farmer landowner	194	86.28	−1.33	20.27	1.72
Maize farmer landowner	228	82.97	−1.70	22.92	3.65
Farmer, other crops	83	84.94	−1.48	17.14	0.95
Tenant rice farmer	94	82.37	−1.70	22.56	0.00
Tenant maize farmer	138	84.22	−1.43	18.01	1.90
Tenant, other crops	53	80.97	−1.82	27.06	1.18
Landless farm laborer	258	83.47	−1.63	21.54	1.03
Wage earner	801	83.09	−1.64	22.05	1.78
Professional/salaried	100	86.53	−1.31	14.87	1.03
Fishermen, boat owners	410	81.23	−1.87	30.63	2.38
Hired fishermen	35	80.03	−2.03	41.42	2.86
Employed overseas	233	83.86	−1.63	20.94	0.49
Occupation unclassified	426	82.75	−1.64	24.78	2.83
Income group[c]					
First quartile (lowest)	763	81.35	−1.84	29.20	2.92
Second quartile	763	82.06	−1.73	26.35	1.80
Third quartile	763	83.40	−1.64	21.98	1.49
Fourth quartile	764	86.07	−1.34	14.86	1.19

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

Note: The z-score is a method used in standardizing the distribution of actual weight of the child relative to the standard weight for a child of that sex and age. The standards devised by the U.S. National Center for Health Statistics (NCHS) were used in the study.

[a] Second-degree malnutrition includes those children between 60 and 75 percent of the standard weight-for-age.

[b] Third-degree malnutrition includes children weighing less than 60 percent of the standard weight-for-age.

[c] These data are for all survey rounds combined.

7

A COMPARATIVE ANALYSIS OF THE EFFECTS OF THE FOOD PRICE SUBSIDY SCHEME

In this chapter the effects of each of the two components of the scheme—price subsidy and nutrition education—are estimated based on direct comparisons between households that received these components and households that did not. As explained earlier, the first survey round was done before the scheme was implemented and the fourth round after the scheme was completed. To avoid the effects of seasonal variations, the third round was done exactly one year after the first and the fourth round one year after the second. Thus, a direct comparison between rounds one and three should yield an estimate of the impact of the scheme provided no other changes took place during the year that influenced the outcome variable. But such changes may have occurred. Therefore a control subsample—one that was not a part of the scheme—is needed. Assuming that any external changes were the same for the control subsample and the subsample participating in the scheme, these external effects can be isolated from the effects of the scheme.

This is the approach used here. Means for control and treatment groups for each survey round and means for survey rounds one and three and two and four were tested statistically for significant differences. Then the changes in the treatment groups from the price subsidy and the nutrition education program were estimated using the methods presented in Chapter 5. Estimates are provided for the impact on household food expenditures, calorie acquisition, and calorie consumption, as well as calorie adequacy of groups of individuals, and mean weight and height for age of preschoolers.

Household Food Expenditures

Household food expenditures increased greatly for all household groups because food prices rose steeply during the study period (Table 13). The increase was larger for households receiving the subsidy, that is, about 9 percent—approximately the size of the subsidy—after the scheme had been in effect for 10 months (Table 14). These households continued to spend more on food after the scheme was discontinued. Households receiving both the subsidy and nutrition education showed the largest increase, but nutrition education without the subsidy does not seem to have influenced food expenditures. Clearly, enhancement of purchasing power of the poor and improvement of their nutrition-related knowledge are strongly complementary. The effect of one is greatly influenced by the presence of the other.

Household Food Acquisition

Household calorie acquisition increased with the introduction of the subsidy and fell back almost to presubsidy levels when the subsidy was discontinued (Table 15). Households receiving the subsidy increased their daily calorie acquisition by about 250 calories per AEU, while the calories acquired by households in the control group actually declined by almost 30 calories per AEU per day. On the assumption that this fall was caused by factors (primarily price increases) that also influenced the subsidized households, the impact of the subsidy was judged to be about 280 calories per AEU per day, including the decrease avoided. Thus, households receiving the subsidy acquired about 19 percent more calories than they would have without the subsidy (Table 16). Although food acquisition fell when the scheme ended, it was still about 11 percent above prescheme levels after adjusting for effects of external factors. Thus, it appears that the

Table 13—Weekly food expenditures for each subsample and survey round

	Survey Round				Levels at Which Means are Significantly Different[a]	
Subsample/Levels of Significance	1	2	3	4	Between Rounds 1 and 3	Between Rounds 2 and 4
Subsample receiving subsidy	20.0	24.2	36.5	34.0	0.001	0.001
With nutrition education	20.4	25.0	36.6	34.2	0.001	0.001
Without nutrition education	19.5	23.3	36.3	33.7	0.001	0.001
Subsample not receiving subsidy	20.4	21.9	34.2	32.9	0.001	0.001
With nutrition education	21.4	22.5	35.8	34.6	0.001	0.001
Without nutrition education	19.4	21.3	32.3	31.3	0.001	0.001
Subsample receiving nutrition education	20.9	23.8	36.2	34.4	0.001	0.001
Subsample receiving no nutrition education	19.5	22.3	34.5	32.5	0.001	0.001
Levels at which means are significantly different[a]						
Subsidy versus no subsidy						
Total sample	n.s.	0.001	0.05	n.s.	0.001	0.001
Subsample receiving nutrition education	n.s.	0.005	n.s.	n.s.	0.001	0.001
Subsample receiving no nutrition education	n.s.	0.05	0.05	0.05	0.001	0.001
Nutrition education versus nutrition education	0.01	n.s.	n.s.	0.05	0.001	0.001

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

[a] Significance is based on t-test; n.s. means not significant at the 0.10 level.

Table 14—Change in household food expenditures due to price subsidy or nutrition education

	Time of Measurement		
Scheme	Two Months After Initiation of Scheme	Ten Months After Initiation of Scheme	Two Months After Termination of Scheme
		(percent)	
Subsidy versus no subsidy			
Total sample	12.7	8.9	5.4
Subsample receiving nutrition education	16.6	7.2	3.7
Subsample receiving no nutrition education	8.8	11.8	7.1
Nutrition education versus no nutrition education	−0.4	−2.1	−1.2

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

Notes: Percentages of change in food expenditures are in comparison to the baseline and corrected for exogenous changes reflected in the control sample. Changes are estimated on the basis of direct comparisons between control and treatment populations. The value of the subsidy was 9.25 percent of food expenditures of households receiving subsidies in survey round 2 and 8.5 percent in round 3.

Table 15—Daily calorie acquisition for each subsample and survey round

Subsample/Levels of Significance	Survey Round				Levels at Which Means are Significantly Different	
	1	2	3	4	Between Rounds 1 and 3	Between Rounds 2 and 4
Subsample receiving subsidy	1,742	2,038	2,009	1,788	0.001	0.001
With nutrition education	1,798	2,063	2,029	1,746	0.001	0.001
Without nutrition education	1,686	2,013	1,989	1,831	0.001	0.001
Subsample not receiving subsidy	1,836	1,793	1,802	1,710	n.s.	0.050
With nutrition education	1,889	1,844	1,873	1,778	n.s.	0.050
Without nutrition education	1,784	1,742	1,731	1,643	n.s.	n.s.
Subsample receiving nutrition education	1,844	1,954	1,951	1,762	0.050	0.001
Subsample receiving no nutrition education	1,735	1,878	1,860	1,737	n.s.	0.005
Levels at which means are significantly different						
Subsidy versus no subsidy						
Total sample	0.050	0.001	0.001	0.050		
Subsample receiving nutrition education	n.s.	0.001	0.005	n.s.		
Subsample receiving no nutrition education	n.s.	0.001	0.001	0.001		
Nutrition education versus no nutrition education	n.s.	n.s.	0.005	n.s.		

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

Note: Levels of significance are based on t-test; n.s. means not significant at the 0.10 level.

Table 16—Change in daily calorie acquisition due to price subsidy or nutrition education

Scheme	Time of Measurement		
	Two Months After Initiation of Scheme	Ten Months After Initiation of Scheme	Two Months After Termination of Scheme
		(percent)	
Subsidy versus no subsidy			
Total sample	20.9	18.6	11.2
Subsample receiving nutrition education	17.8	14.0	3.4
Subsample receiving no nutrition education	21.6	21.0	17.3
Nutrition education versus no nutrition education	−2.1	−1.3	−4.6

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

Notes: Percentages of change are in comparison to the baseline and corrected for exogenous changes reflected in the control sample. Changes are estimated on the basis of direct comparisons between control and treatment populations.

scheme had a long-term effect on food acquisition over and above the effect of the income transfer itself. This effect does not seem to originate with nutritional education, which, if anything, had a negative effect on calorie acquisition.

Household Calorie Consumption

According to data from 24-hour food weighing, household calorie consumption by subsidized households increased slightly, although these changes were not statistically significant. During the same period, calories consumed by nonsubsidized households decreased significantly (Table 17). Thus it appears that the subsidy effectively countered a decrease stemming from other factors and resulted in calorie consumption about 10 percent above what it would have been without the subsidy (Table 18). The negative effects of external factors are fully reflected in the calorie consumption of the subsidized households after the scheme was discontinued. Whereas consumption levels of the two groups were significantly different during the latter part of the scheme, this difference disappeared as soon as the scheme was terminated, leaving both groups consuming less than before. Nutrition education appears to have had little or no effect on calorie consumption as measured by 24-hour food weighing.

Calorie Consumption by Individuals

The calorie adequacy rate increased during the period of the subsidy and fell after the subsidy was terminated for virtually all members of subsidized households (Tables 19 and 20). But adult males and females appear to have gained considerably more from the scheme than children. Some of the adults' relative gain seems to have been maintained after the scheme was discontinued. However, school-aged children, who did gain some from the scheme, were considerably worse off after the scheme was terminated than before it was initiated. There is no obvious explanation for this phenomenon.

Table 17—Daily household calorie consumption for each subsample and survey round

	Survey Round				Levels at Which Means are Significantly Different	
Subsample/Levels of Significance	**1**	**2**	**3**	**4**	**Between Rounds 1 and 3**	**Between Rounds 2 and 4**
Subsample receiving subsidy	1,741	1,676	1,788	1,651	n.s.	n.s.
With nutrition education	1,724	1,669	1,804	1,613	0.050	n.s.
Without nutrition education	1,757	1,684	1,772	1,688	n.s.	n.s.
Subsample not receiving subsidy	1,751	1,763	1,639	1,689	0.001	0.050
With nutrition education	1,791	1,814	1,636	1,717	0.001	n.s.
Without nutrition education	1,710	1,710	1,641	1,661	n.s.	n.s.
Subsample receiving nutrition education	1,738	1,742	1,720	1,665	n.s.	0.050
Subsample receiving no nutrition education	1,734	1,697	1,707	1,675	n.s.	n.s.
Levels at which means are significantly different						
Subsidy versus no subsidy						
Total sample	n.s.	0.050	0.001	n.s.		
Subsample receiving nutrition education	n.s.	0.005	0.001	0.050		
Subsample receiving no nutrition education	n.s.	n.s.	0.001	n.s.		
Nutrition education versus no nutrition education	n.s.	n.s.	n.s.	n.s.		

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

Notes: Levels of significance are based on t-test; n.s. means not significant at the 0.10 level.

Table 18—Change in daily household calorie consumption due to price subsidy or nutrition education

	Time of Measurement		
Scheme	Two Months After Initiation of Scheme	Ten Months After Initiation of Scheme	Two Months After Termination of Scheme
		(percent)	
Subsidy versus no subsidy			
Total sample	−4.4	9.7	−1.7
Subsample receiving nutrition education	−4.4	14.5	−2.4
Subsample receiving no nutrition education	−4.2	5.9	−1.1
Nutrition education versus no nutrition education	2.4	0.5	−0.8

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

Notes: Percentages of change are in comparison to the baseline and corrected for exogenous changes reflected in the control sample. Changes are estimated on the basis of direct comparisons between control and treatment populations.

According to this measurement, nutrition education had a significant and positive effect on the calorie adequacy of most groups, especially pregnant and lactating women, when provided along with food subsidies. No impact is detected when nutrition education was provided alone, confirming once again the importance of providing nutrition education together with expanded purchasing power.

Nutritional Status

The weight-for-age of the preschoolers in the sample relative to standard weight-for-age increased during the study period (Table 21). The increase was largest for preschoolers in the households that participated in the subsidy scheme (Table 22). Based on these comparisons, it may be concluded that the scheme improved the average weight of the preschoolers relative to the standards. The effects continued for at least two months beyond the termination of the scheme. Nutrition education does not appear to have contributed to these improvements.

Table 23 shows changes in the height-for-age of the preschoolers studied. A general increasing trend was found in all groups. The increase was slightly larger among preschoolers from subsidized households. Thus, it appears that the scheme caused an increase in height of 2.7 percent during the first 10 months of its existence. The effect was slightly higher in the group receiving both subsidy and nutrition education than in those receiving only one of those components (Table 24).

Table 19—Individual calorie adequacy by age and gender for each subsample and survey round

	Adults					Children					
				All > 14 Years		1-7 Years		7-14 Years		All	
Survey Round/ Sample	Husbands	Wives	Pregnant/ Lactating Women	Male	Female	Male	Female	Male	Female	Male	Female
					(percent)						
Survey round 1											
Subsidized											
With education	0.73	0.78	0.65	0.75	0.79	0.55	0.56	0.66	0.61	0.67	0.66
Without education	0.70	0.74	0.70	0.73	0.78	0.60	0.57	0.72	0.77	0.67	0.69
Nonsubsidized											
With education	0.96	0.88	0.71	0.90	0.81	0.55	0.57	0.64	0.59	0.73	0.71
Without education	0.85	0.71	0.56	0.74	0.69	0.67	0.46	0.64	0.51	0.69	0.59
Survey round 2											
Subsidized											
With education	0.88	0.86	0.76	0.85	0.86	0.63	0.62	0.65	0.68	0.73	0.73
Without education	0.78	0.87	0.77	0.79	0.82	0.62	0.61	0.65	0.65	0.68	0.71
Nonsubsidized											
With education	0.85	0.78	0.67	0.79	0.76	0.56	0.53	0.69	0.55	0.68	0.63
Without education	0.68	0.72	0.60	0.62	0.69	0.60	0.38	0.41	0.47	0.58	0.55
Survey round 3											
Subsidized											
With education	0.88	0.84	0.79	0.82	0.85	0.66	0.61	0.72	0.69	0.74	0.73
Without education	0.82	0.82	0.77	0.81	0.85	0.60	0.62	0.61	0.56	0.68	0.72
Nonsubsidized											
With education	0.77	0.76	0.73	0.75	0.77	0.55	0.54	0.66	0.55	0.66	0.66
Without education	0.80	0.76	0.62	0.69	0.71	0.62	0.54	0.65	0.58	0.65	0.63
Survey round 4											
Subsidized											
With education	0.72	0.80	0.71	0.68	0.80	0.65	0.52	0.61	0.52	0.66	0.64
Without education	0.70	0.74	0.72	0.72	0.80	0.71	0.67	0.68	0.58	0.70	0.70
Nonsubsidized											
With education	0.85	0.80	0.71	0.81	0.77	0.60	0.62	0.74	0.64	0.71	0.69
Without education	0.88	0.76	0.71	0.82	0.76	0.68	0.45	0.72	0.71	0.72	0.64

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

Table 20—Change in calorie adequacy for selected groups of individuals due to price subsidy or nutrition education

Scheme	Husbands			Wives			Adult Males			Adult Females		
	a	b	c	a	b	c	a	b	c	a	b	c
	(percent)											
Subsidy versus no subsidy												
Total sample	36.4	37.9	5.8	20.7	15.0	3.9	28.0	26.2	−5.4	9.2	9.1	−1.4
Subsample receiving nutrition education	36.2	50.3	11.4	24.4	24.7	12.8	29.1	31.2	0.7	16.0	13.2	6.5
Subsample receiving no nutrition education	39.3	24.5	−3.4	15.9	3.5	−6.6	29.2	19.0	−11.0	5.1	5.9	−6.9
Nutrition education versus no nutrition education (total sample)	9.4	−6.0	−8.2	−9.9	−10.9	−6.2	3.0	−6.1	−13.2	−1.4	−3.9	−6.3

Scheme	Pregnant or Lactating Women			Male Children 1-7 Years			Female Children 1-7 Years		
	a	b	c	a	b	c	a	b	c
	(percent)								
Subsidy versus no subsidy									
Total sample	13.2	8.0	−4.6	14.2	12.3	11.8	23.0	4.7	1.4
Subsample receiving nutrition education	23.9	18.2	9.2	12.5	20.0	8.3	19.1	15.0	−14.6
Subsample receiving no nutrition education	2.7	−0.7	−18.9	15.4	8.1	16.6	29.6	−7.3	20.2
Nutrition education versus no nutrition education (total sample)	−3.3	0.6	−8.6	14.5	16.4	4.7	5.8	−8.8	−7.1

Scheme	Male Children 8-14 Years			Female Children 8-14 Years			All Males			All Females		
	a	b	c	a	b	c	a	b	c	a	b	c
	(percent)											
Subsidy versus no subsidy												
Total sample	9.6	−5.8	−17.4	4.7	−11.9	−35.5	19.4	13.4	0.1	16.7	7.4	−7.3
Subsample receiving nutrition education	−8.7	5.8	−20.1	19.6	21.3	−21.4	17.0	22.2	1.3	24.7	19.0	−0.2

(continued)

Table 20—Continued

Subsample receiving no nutrition education	40.9	−16.6	−16.1	−8.4	−36.1	−45.9	20.7	7.7	0.1	10.4	−2.3	−6.5
Nutrition education versus no nutrition education (total sample)	32.3	14.6	1.6	18.1	16.0	−4.8	9.5	1.5	−5.6	0.1	−4.5	−7.3

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

Notes: Percentage of change in food expenditures are in comparison to the baseline and corrected for exogenous changes reflected in the control sample. Changes are estimated on the basis of direct comparisons between control and treatment populations. The value of the subsidy was 9.25 percent of food expenditures of households receiving subsidies in survey round 2 and 8.5 percent in round 3. a is the survey round 2 months after initiation of the scheme; b is the survey round 10 months after initiation of the scheme; and c is the survey round 2 months after termination of the scheme.

Table 21—Mean weight-for-age of all preschoolers for each subsample and survey round

Subsample/Levels of Significance	Survey Round 1	Survey Round 2	Survey Round 3	Survey Round 4	Levels at Which Means are Significantly Different: Between Rounds 1 and 3	Levels at Which Means are Significantly Different: Between Rounds 2 and 4
	(percent)					
Subsample receiving subsidy	77.3	81.2	84.4	84.9	0.001	0.001
With nutrition education	79.9	81.5	83.9	85.3	0.001	0.005
Without nutrition education	74.4	80.9	85.1	84.6	0.001	0.005
Subsample not receiving subsidy	84.3	84.2	82.2	83.3	n.s.	n.s.
With nutrition education	82.8	81.6	81.0	81.6	n.s.	n.s.
Without nutrition education	85.7	86.4	83.4	84.9	0.050	0.050
Subsample receiving nutrition education	80.4	81.0	82.7	83.7	0.001	0.010
Subsample receiving no nutrition education	81.4	83.5	84.2	84.6	0.001	0.001
Levels at which means are significantly different						
Subsidy versus no subsidy						
Total sample	0.05	n.s.	0.005	0.005		
Subsample receiving nutrition education	0.05	n.s.	n.s.	0.050		
Subsample receiving no nutrition education	n.s.	n.s.	0.005	0.050		
Nutrition education versus no nutrition education	n.s.	n.s.	n.s.	n.s.		

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

Notes: Levels of significance are based on t-test; n.s. means not significant at 0.10 level.

Table 22—Change in weight-for-age of preschoolers due to price subsidy or nutrition education

Scheme	Time of Measurement: Two Months After Initiation of Scheme	Time of Measurement: Ten Months After Initiation of Scheme	Time of Measurement: Two Months After Termination of Scheme
		(percent)	
Subsidy versus no subsidy			
Total sample	5.3	12.1	11.3
Subsample receiving nutrition education	3.5	7.3	8.3
Subsample receiving no nutrition education	8.0	17.4	14.9
Nutrition education versus no nutrition education	−1.7	0.7	−0.3

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

Notes: Percentages of change are in comparison to the baseline and corrected for exogenous changes reflected in the control sample. Changes are estimated on the basis of direct comparisons between control and treatment populations.

Table 23—Mean height-for-age of all preschoolers for each subsample and survey round

	Survey Round				Levels at Which Means are Significantly Different	
Subsample/Levels of Significance	1	2	3	4	Between Rounds 1 and 3	Between Rounds 2 and 4
			(percent)			
Subsample receiving subsidy	89.8	91.3	93.4	93.2	0.001	0.001
With nutrition education	89.2	90.7	93.7	93.0	0.001	0.005
Without nutrition education	90.7	91.9	93.2	93.3	0.010	n.s.
Subsample not receiving subsidy	91.8	92.0	93.0	92.4	0.050	n.s.
With nutrition education	92.8	93.4	94.7	94.4	0.050	n.s.
Without nutrition education	90.9	90.8	91.4	90.7	n.s.	n.s.
Subsample receiving nutrition education	90.7	91.8	94.1	93.6	0.001	0.010
Subsample receiving no nutrition education	90.8	91.4	92.4	92.2	0.010	n.s.
Levels at which means are significantly different						
Subsidy versus no subsidy						
Total sample	0.005	n.s.	n.s.	n.s.		
Subsample receiving nutrition education	0.001	0.001	n.s.	n.s.		
Subsample receiving no nutrition education	n.s.	n.s.	0.050	0.001		
Nutrition education versus no nutrition education	n.s.	n.s.	0.010	0.050		

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

Notes: Levels of significance are based on t-test; n.s. means not significant at the 0.10 level.

Table 24—Change in height-for-age of preschoolers due to price subsidy or nutrition education

	Time of Measurement		
Scheme	Two Months After Initiation of Scheme	Ten Months After Initiation of Scheme	Two Months After Termination of Scheme
		(percent)	
Subsidy versus no subsidy			
Total sample	1.4	2.7	3.1
Subsample receiving nutrition education	1.0	2.9	2.5
Subsample receiving no nutrition education	1.4	2.2	3.1
Nutrition education versus no nutrition education	0.5	2.0	1.6

Notes: Percentages of change are in comparison to the baseline and corrected for exogenous changes reflected in the control sample. Changes are estimated on the basis of direct comparisons between control and treatment populations.

8

A MULTIVARIATE ANALYSIS OF THE EFFECTS OF THE FOOD SUBSIDY SCHEME

Direct static comparisons may not yield reliable results because the effects of the scheme are not effectively separated from the effects of other factors.[20] Therefore, in this chapter comparative analysis is supplemented with empirical results of multivariate analysis, employing the analytical methodology presented in Chapter 5.

A comparison of the food consumption patterns between the first (baseline) survey and the subsequent survey rounds indicates that the rationed subsidies for rice were inframarginal for about 90 percent of the recipient households. On average, rice acquisition per capita was estimated at 118 kilograms annually before the subsidy was introduced, whereas the per capita ration was only 60 kilograms per year. For cooking oil, however, the rationed quantity was extramarginal. On average, per capita intake of cooking oil was about 2.20 kilograms per year, while the subsidized quantity was estimated at 4.70 kilograms per year.

Effects on Household Food Expenditures and Calorie Acquisition

The parameters of equation (3) in Chapter 5 are estimated by ordinary least squares from the pooled sample from the four survey rounds. The regression results are reported in the Appendix, Table 34, and the parameter estimates for the key variables are summarized in Table 25. The estimated price and income elasticities and the MPCs are reported in Table 26. As shown in Table 25, changes in household income significantly affected both food expenditures and calorie acquisition. Furthermore, the subsidy seems to have had an impact on these household variables over and above the effect expected from the real income embodied in the subsidy. Changes in the price of rice did not have a significant effect on either food expenditures or calorie acquisition. Changes in the price of cooking oil affected food expenditures as well as calorie acquisition significantly. No significant effect of the nutrition education component of the scheme was detected.

The estimated income elasticity for total food expenditures, which was about 0.68, is in the plausible range and is similar to those obtained in studies of Sri Lanka (0.72), Thailand (0.65), Egypt (0.69), and Bangladesh (0.67).[21] The calorie acquisition elasticity of 0.33 is about half of the food expenditure elasticity, indicating that even poor rural households have a tendency to shift to higher-priced sources of calories as incomes increase.[22] Thus, the average increase in household incomes of 8.0 percent brought about by the rice and oil subsidy is estimated to have caused an increase of 5.6 percent

---

[20] Per Pinstrup-Andersen, "An Analytical Framework for Assessing Nutrition Effects of Policies and Programs," *Food Policy,* ed. Charles K. Mann and Barbara Huddleston (Bloomington: Indiana University Press, 1985), pp. 55-66

[21] David E. Sahn, "Malnutrition and Food Consumption in Sri Lanka: An Analysis of Changes from 1969 to 1982," International Food Policy Research Institute, Washington, D.C., 1986 (mimeographed); Trairatvorakul, *Effects on Income Distribution and Nutrition;* Alderman and von Braun, *Effects of the Egyptian Food Ration and Subsidy System;* and Odin K. Knudsen and Pasquale L. Scandizzo, *Nutrition and Food Needs in Developing Countries,* Staff Working Paper 328 (Washington, D.C.: World Bank, 1979).

[22] This value is about the same as the average estimated by Alderman for a number of countries (Harold Alderman, *The Effect of Food Price and Income Changes on the Acquisition of Food by Low-Income Households* [Washington, D.C.: International Food Policy Research Institute, 1986]).

Table 25—Key coefficients for household food expenditure and food acquisition regressions

Independent Variable	Dependent Variable			
	Household Food Expenditures		Household Calorie Acquisition	
	Model A-1	Model A-2	Model B-1	Model B-2
	(pesos/AEU/day)		(calories/AEU/day)	
Log income	2.20 (57.82)[a]	2.16 (56.72)[a]	633.29 (27.37)[a]	623.07 (27.00)[a]
Subsidy	0.03 (7.30)[a]	0.16 (4.96)[a]	8.94 (3.32)[a]	68.23 (3.34)[a]
Price of rice	0.006 (0.37)	0.006 (0.34)	−12.11 (−1.12)	−12.22 (1.12)
Price of cooking oil	0.012 (4.11)[a]	0.004 (1.49)	−5.98 (3.51)[b]	−7.45 (5.14)[a]
Nutrition education	−0.02 (−0.73)	−0.02 (−0.86)	22.67 (1.28)	21.86 (1.24)
Regression R^2	0.73	0.72	0.38	0.38
N	2,509	2,509	2,509	2,509

Notes: The adult equivalent unit (AEU) is a method used to convert the consumption of persons of different ages and sex to standard consumption units. The complete set of coefficients is given in the Appendix, Table 34. The figures in parentheses are t-ratios.

[a] Significant at the 5 percent level.

[b] Significant at the 10 percent level.

in total food expenditures and 2.6 percent in calorie acquisition if the income transfer from the subsidy is treated the same as other income.

The estimated price elasticities for rice of −0.006 to −0.020 and −0.020 to −0.050 for cooking oil seem low, but these should not be confused with own-price elasticities. The price elasticities shown in Table 26 are price elasticities for total food expenditures and total calories, and they show the net effect after substitutions among commodities have taken place. Therefore, they would be expected to be lower than direct price elasticities for individual foods.

One of the issues addressed in this study—whether the subsidy scheme influences household food consumption over and above the effect of the income transfer as measured by the income elasticity above—is tested and evaluated using two different model specifications (see Chapter 5). As reported in Table 25, the subsidy component of the pilot scheme positively affects both household food expenditures and calorie acquisition: it is highly significant. The effect detected by the subsidy term is over and above the price and income effects. The effect of the nutrition education component of the pilot scheme is weak but positive. Although significant at only a 0.20 level, it appears important as a complementary intervention in the scheme. To further explore the effects of nutrition education on households, interaction between nutrition education and the subsidy—that is, both schemes operating simultaneously—are tested in regressions. Such tests indicate no differential effects of nutrition education-subsidy interaction on calorie and food acquisition.

The estimates of absolute effects can be gleaned from the MPCs and the price and income elasticities. The MPC results show that an additional P 1.00 of subsidy income would add P 0.69-0.98 to food expenditures. The 0.50 MPC for expenditures on food from all income sources other than subsidies is within the range usually found in poor rural areas in the developing world.

Table 26—Parameters for estimating the impact of the pilot subsidy scheme on household food expenditures and calorie acquisition

Independent Variable	Dependent Variable			
	Household Food Expenditures		Household Calorie Acquisition	
	Model A-1	Model A-2	Model B-1	Model B-2
Marginal propensity to consume				
All income net of subsidy	0.50[a]	0.53[a]	142[b]	153[b]
Subsidy income	0.98[a]	0.69[a]	363[b]	222[b]
Consumption parameters				
Income elasticity (net of subsidy)	0.66	0.70	0.32	0.34
Rice price elasticity	−0.01	−0.01	−0.02	−0.02
Oil price elasticity	−0.04	−0.04	−0.04	−0.04
Nutrition education effects	0.02	0.02	22.67	21.86

Notes: See the Appendix, Table 34, for a complete set of regression coefficients. The adult equivalent unit (AEU) is a method used to convert the consumption of persons of different ages and sex into standard consumption units.

[a] Pesos per AEU per day.

[b] Calories per AEU per day.

The difference in the MPC between cash and subsidy incomes is also large for calories. Thus, the marginal propensity to increase calorie consumption from subsidy income is about twice that of the MPC for all other sources of income. In absolute terms, every additional peso of subsidy increases calorie consumption by 222-363 calories per AEU. The impact of an additional peso of other income is about 150 calories per AEU.

Different MPCs for different sources of household income have also been found in other studies of consumption behavior in both developed and developing countries. In Kerala, India, there is evidence that participation in rice subsidy programs increased the MPCs of some households.[23] Several studies on the consumption effect of food stamps on U.S. households indicate that the MPC for subsidy transfer is twice to three times that of the MPC for money income.[24]

The behavioral change that caused a higher MPC for subsidy income cannot be fully explained. Perhaps the scheme generated an increased awareness among participants about food and nutrition needs over and above the explicit nutrition education intervention that accompanied the price subsidy. It is conceivable that mothers' awareness of the nutritional objectives of the scheme helped realign family budget priorities. In the pilot scheme, there was a strong persuasive element introduced by efforts to draw mothers into nutrition education classes administered by the extension workers.

Another plausible explanation is that the use of rice and oil as the food commodities in the scheme altered food budgets in such a way that the caloric content per unit of the household's food bundle was increased. Per capita daily calories acquired from rice increased from 326 grams prior to the subsidy to 423 grams when the subsidy was in force. Daily calories acquired from cooking oil increased by 30 percent. This raised the MPC for calories for some of the families. The calorie density per kilogram of rice and oil is about twice that of foods in the average food bundle of the study households. Thus, in designing a project it is important to consider not only the economic value of the subsidized good but also its nutritive value if the program is to be nutritionally effective.

---

[23] Shubh Kumar, *The Impact of Subsidized Rice on Food Consumption and Nutrition in Kerala,* Research Report 5 (Washington, D.C.: International Food Policy Research Institute, 1979).

[24] Senauer and Young, "Impact of Food Stamps on Food Expenditures."

Evaluated at their mean values, the total energy increase from the scheme is equivalent to 136-138 calories per AEU per day. This calorie effect combines net income effects, price effects, and effects caused by higher MPCs for subsidy. The scheme's total impact on calories is equivalent to 7 percent of the calories consumed per person in the study households. In terms of food expenditures, the scheme effectively increased total food budgets by P 0.27-0.34 per AEU per day, basically the same as the average transfer value of the subsidy, which was P 0.31 per AEU per day.

Household income can be influenced by decisions regarding the allocation of time of each household member to various activities, including income earning. Food subsidies may cause a change in time allocation in general and in the allocation of time to income-earning activities in particular. Thus, it may be hypothesized that the subsidies reduced the time allocated to income-earning activities. This implies substitution between the real income embodied in the subsidies and household income from other sources.

Such substitution is ignored in the models used here and, if it is significant, the models overestimate the effect of the subsidies. To explore whether such a substitution occurred, the household income variable was replaced by predicted wage rates for the husband and wife of each household, and the models were rerun. Neither the size of the coefficient of the subsidy variable nor its level of significance changed appreciably. Furthermore, when the number of hours worked in income-earning activities and household incomes excluding the subsidy value were regressed on the value of the subsidy and a set of other variables, no significant effect of the subsidy on hours worked or household incomes from sources other than the subsidies was detected. Thus, it appears that the use of household incomes as an explanatory variable is acceptable for estimating the effect of the scheme.

Effects of Other Factors

The regression of food expenditures on household size gives negative and significant results, indicating that the presence of more family members reduces food consumption per AEU. Household size is generally more closely related to food expenditures than to calorie acquisition.

The education of the wife is strongly correlated with food expenditures, after controlling for incomes and nutrition education: the more educated the wife, the more she is likely to spend on food for the household. Perhaps she purchases more expensive calories, such as processed foods, because the opportunity cost of time spent on food preparation increases with education. Or perhaps higher education leads to a better understanding of the importance of adequate nutrition. Evidence from Nicaragua and elsewhere indicates that women's schooling plays a substantial role in family nutrition.[25] Higher education of the husband does not appear to affect food expenditures or calorie acquisition significantly.

Participation in food assistance programs such as those administered by Catholic Relief Services, CARE, and the World Food Programme significantly affected food expenditures and calorie acquisition among the study households (Appendix Table 34). The quantities received by households from such programs are not included in the estimates of total food expenditures or calories, and the significant and negative sign demonstrates that food from these programs was substituted for food from other sources.

The regressions show that a large share of total household income earned by women is associated positively with food expenditures and negatively with calorie acquisition (Appendix Table 34). This is consistent with the hypothesis that households where the opportunity cost of women's time is high tend to purchase more expensive calories—such as processed foods—to reduce food preparation time.

---

[25] Jere Behrman and Barbara Wolfe, "More Evidence on Nutrition Demand: Income Seems Overrated and Women's Schooling Underemphasized," *Journal of Development Economics* 14 (January-February 1984): 105-128.

The degree to which households supply their own food is partly captured by the OWNFARM and OWNGARDEN variables. These variables significantly and positively affect calorie acquisition. The positive sign on total calorie effects indicates that households with a higher ratio of own-produce, all things being equal, tend to acquire more calories. Under the definition the calorie acquisition term covers calories from both purchased and own-produced foods.

Effects on Consumption of Rice, Oil, Fish, and Maize

The subsidy component of the scheme had a positive and significant effect on the consumption of rice, oil, and fish and a negative effect on the consumption of maize (Table 27). The MPC for rice from total household income, excluding the subsidy, is estimated to be 88 calories or slightly more than one-half of the MPC for total calories. The MPC from subsidy income is 210 calories compared to 220 for total calories. Thus, the increase in total calorie consumption brought about by the subsidy is almost totally accounted for by increasing rice consumption. The MPC for oil is 20 calories from the subsidy and 8 calories from other incomes.

The income elasticity is estimated to be about 0.2 for rice, 0.4 for oil, and 0.5 for fish, while it is negative but nonsignificant for maize. Own-price elasticities for rice and maize are negative but not significantly different from zero. Own-price elasticities for oil and fish are estimated to be about −0.6 and −0.8, respectively. Thus, price subsidies for extramarginal quantities of oil would be expected to increase oil consumption by 6 percent for each 10 percent reduction in its price. The nutrition education component of the scheme appears to have had a positive and significant impact on rice consumption.

Effects on Calorie Consumption by Preschool Children

As reported in Table 28 and in the Appendix, Table 36, calorie demand equations for individual preschoolers yielded statistically significant coefficients for the income and subsidy variables.

The scheme resulted in an additional effect on calories consumed by preschoolers over and above the effect operating through increases in the households' incomes and calorie consumption. This may be partly explained by the families' increased awareness of the nutritional problems of children. The regular monitoring of children's weights, conducted as part of the experiment, may have increased the mothers' awareness, especially since the nutrition education campaign stressed the importance of correct child feeding practices.

According to the demand models, the impact of the pilot scheme on daily calorie consumption of preschoolers between ages 13 and 83 months was 31-55 calories per child—about 3 to 6 percent of the average calorie intake of preschoolers in the sample. These figures are below the average estimated for the household both in absolute terms and relative to individual calorie requirements. For the household, the average effects per AEU were in the neighborhood of 136-138 calories per day.

Effects on the Nutritional Status of Children

Whether the calorie increases for preschool children resulting from the subsidy scheme translated into child growth is a critical question from a policy standpoint. An increase in calorie consumption may be viewed not as a measure of the ultimate outcome of policy, but rather as a measure of an intermediate outcome. This distinction is often critical in measuring the impact of a program. Indexes of child health and nutritional well-being are considered by many to be important indicators of current economic welfare of developing countries. It is one set of measures of the quality of

Table 27—Key coefficients and parameters for estimating the impact of the pilot subsidy scheme on the acquisition of rice, maize, oil, and fish

	Dependent Variable: Calorie Acquisition Per AEU Per Day			
Independent Variable	**Rice**	**Maize**	**Oil**	**Fish**
Log income per AEU				
(including subsidy)	333.13	−32.67	28.55	39.64
	(9.29)[a]	(−0.96)	(6.50)[a]	(6.14)[a]
Dummy for subsidy	122.02	−104.79	12.22	52.40
	(3.89)[a]	(−3.53)[a]	(3.18)[a]	(9.27)[a]
Price of rice	−5.81	33.87	−1.62	4.10
	(−0.35)	(2.15)[a]	(−0.79)	(1.37)
Price of maize	7.89	−11.12	0.54	0.22
	(0.65)	(−0.97)	(0.36)	(0.10)
Price of oil	−10.66	7.97	−4.22	−0.77
	(−4.76)[b]	(3.77)[a]	(−15.41)[a]	(−1.90)[b]
Price of fish	−3.90	−5.51	−0.43	−7.57
	(−1.23)	(−1.82)	(−1.09)	(−13.20)[a]
Nutrition education	78.14	14.92	3.01	−4.27
	(2.28)[a]	(0.58)	(0.91)	(−0.88)
R^2	0.15	0.16	0.23	0.34
Number of observations	2,131	2,131	2,131	2,131
Marginal propensity to consume[c]				
All incomes (net of subsidy)	88	−9	8	10
Subsidy income	210	−113	20	63
Consumption parameters				
Income elasticity (net of subsidy)	0.23	−0.18	0.38	0.52
Price elasticity				
Rice	−0.01	0.55	−0.06	0.16
Maize	3.0×10^{-4}	−0.004	4.0×10^{-4}	1.7×10^{-4}
Oil	−0.08	0.49	−0.62	−0.11
Fish	−0.02	−0.24	−0.05	−0.78
Nutrition education effects	78.14[a]	14.92	3.01	−4.27
Impact of subsidy on acquisition (calories per AEU per day)	227	−108	15	56

Notes: The numbers in parentheses are t-values. The adult equivalent unit (AEU) is a method used to convert the consumption of persons of different ages and sex into standard consumption units.
[a] Significant at the 5 percent level.
[b] Significant at the 10 percent level.
[c] Calories per AEU per peso.

life, which is itself a policy objective. A child's good health and nutritional status significantly influence his or her intelligence, health, and nutritional status as an adult and have a direct impact on adult productivity and earnings.[26]

The current state of knowledge on how to measure the effects of an intervention program on child nutritional status is quite poor, partly because of the difficulty in modeling the interactions among biological, behavioral, cultural, environmental, and socioeconomic factors that influence the nutritional status and health of children. It is quite possible, for example, that an increase in calories may increase energy

---

[26] Barbara Wolfe and Jere Behrman, "Determinants of Child Mortality, Health, and Nutrition in a Developing Country," *Journal of Development Economics* 11 (No. 1, 1982): 163-193.

Table 28—Regressions of calorie intake of children aged 13 to 83 months

Independent Variable	Dependent Variable: Calorie Intake Per Day Model A-1	 Model A-2	 Model B-1	 Model B-2
Log income per AEU per day	140.39 (3.64)[a]	129.05 (3.35)[a]	. . .	. . .
Household calorie acquisition per AEU per day	. . .	. . .	0.10 (3.34)[a]	0.09 (3.02)[a]
Subsidy	11.34 (3.64)[a]	100.27 (3.31)[a]	9.87 (2.87)[a]	88.35 (2.87)[a]
Price of rice	68.60 (1.91)[b]	45.87 (1.37)	63.36 (1.76)[b]	43.71 (1.31)
Price of cooking oil	−0.34 (−0.54)	−0.25 (−0.40)	−0.37 (−0.58)	−0.28 (−0.44)
Nutrition education	−55.97 (−1.90)[b]	−55.48 (−1.88)[b]	−62.14 (2.10)[a]	−61.21 (−2.07)[b]
R^2	0.43	0.43	0.43	0.43

Note: See the Appendix, Table 36, for the complete set of regressions. The numbers in parentheses are t-values.

[a] Significant at the 5 percent level.

[b] Significant at the 10 percent level.

expenditures and thereby improve the wellbeing of the child without changing anthropometry. There are also many measurement problems associated with anthropometric variables. In most cases, regression analyses based on cross-sectional data give very low R^2, indicating an insubstantial knowledge of factors that influence nutritional status or an inability to quantify and incorporate these factors into regression analysis.

The anthropometric data in this study—weight, height, and age of preschool children—were collected monthly from a panel of children from study households prior to and during the time the scheme was in force.

As opposed to the various food-related measures of outcome used in calorie regressions, anthropometric indicators reflect both food- and health-related factors. Thus, the statistical estimate of effect must be able to control for factors such as age, sex, birth order, breast-feeding, morbidity, and child care, which, along with household variables such as family size, education of parents, and accessibility to clean water are expected to influence the nutritional status of preschoolers.

A complete list of the explanatory variables used in the regressions and the estimated coefficients is given in the Appendix, Tables 37 to 41. Table 29 shows the key coefficients for estimating the impact of the scheme, using the five indicators of nutritional status as dependent variables.

Increases in household incomes appear to have a positive effect on all five anthropometric indicators. This effect is highly significant for the short-term indicators, weight and weight-for-age. The subsidy does not seem to influence nutritional status over and above the effect of the income from the subsidy. The nutrition education component of the scheme appears to have had a positive impact on both short- and long-term indicators.

As shown in the Appendix, Tables 37-41, a number of other variables appear to influence the nutritional status of preschoolers. These include diarrhea in the recent past, birth order, access to clean drinking water, and household size.

Table 29—Key coefficients for nutritional status regressions

	Independent Variables					
Dependent Variable	Log Income Per AEU Per Day	Subsidy	Price of Rice	Price of Cooking Oil	Nutrition Education	Regression R^2
Weight						
Percent of total income	0.68	0.03	−0.04	46×10^{-4}	0.25	0.72
	(3.33)[a]	(1.44)	(−0.23)	(1.37)	(1.59)	
Dummy	0.68	−0.12	−0.21	59×10^{-4}	0.21	0.72
	(3.28)[a]	(−0.76)	(−1.17)	(1.77)[b]	(1.30)	
Weight as a percent of standard weight-for-age						
Percent of total income	3.78	0.21	0.30	0.02	2.27	0.14
	(2.77)[a]	(1.71)[b]	(0.23)	(1.08)	(2.17)[b]	
Dummy	3.70	−0.70	−0.92	0.03	1.94	0.14
	(2.70)[a]	(−0.65)	(−0.77)	(1.52)	(1.86)[b]	
Z-scores of weight-for-age						
Percent of total income	0.42	0.03	0.01	87×10^{-5}	0.28	0.12
	(2.43)[a]	(1.97)[a]	(0.06)	(0.31)	(2.08)[a]	
Dummy	0.41	−0.11	−0.17	23×10^{-4}	0.23	0.12
	(2.35)[a]	(−0.79)	(−1.12)	(0.81)	(1.71)[b]	
Z-scores of weight-for-height						
Percent of total income	0.24	0.04	0.43	11×10^{-5}	−0.17	0.11
	(1.40)	(2.48)[b]	(2.68)[b]	(−0.04)	(−1.29)	
Dummy	0.21	0.10	0.28	91×10^{-5}	−0.20	0.10
	(1.25)	(0.75)	(1.87)[b]	(0.33)	(−1.51)	
Height as a percent of standard height-for-age						
Percent of total income	1.11	−0.03	−2.03	−0.02	2.01	0.16
	(1.38)	(−0.37)	(−2.71)[a]	(−1.20)	(3.29)[a]	
Dummy	1.16	−0.82	−2.16	−0.02	1.94	0.17
	(1.45)	(−1.31)	(−3.11)[a]	(−1.33)	(3.17)[a]	

Notes: See the Appendix, Table 36, for the complete set of regressions. The numbers in parentheses are t-values.

[a] Significant at the 5 percent level.

[b] Significant at the 10 percent level.

9

COST-EFFECTIVENESS ANALYSIS

Food price subsidy schemes are but one of many instruments that governments use to alleviate calorie-protein deficiencies and to improve nutrition among poor households. In the Philippines, existing interventions focus on growth monitoring, extension of nutrition education to mothers, and direct supplemental feeding of malnourished children. Several other schemes that are health-related (such as immunization, mother and child health care, oral rehydration) and community-based schemes, such as home and community gardens, have been implemented with varying degrees of cost and effectiveness.[27] Although these interventions have reached a significant proportion of the high-risk population, their impact and relative cost-effectiveness are not clear.

In this chapter the cost-effectiveness of the pilot subsidy scheme will be measured in absolute terms and relative to other nutrition-related intervention programs or policies. Cost comparisons often suffer from lack of adequate data, particularly regarding the net effects of programs. Varying degrees of methodological rigor also make meaningful comparisons among the various types of interventions and programs difficult. For these reasons, the following analysis deals mostly with determining the cost-effectiveness of the scheme itself. Comparative analyses with other nutrition-related interventions will be included to the extent permitted by availability of estimates of the effectiveness of other programs.

Program Cost

The fiscal cost of operating the food price subsidy scheme is given in Table 30. The items reflected are, strictly speaking, government financial or fiscal costs, as they refer to explicit budgetary costs. Economic or implicit costs of the subsidies and the transaction costs incurred by beneficiaries are ignored.

The fiscal cost of the subsidy scheme consists of three main components: the cost of the price subsidy, the cost of the incentive paid to retailers, and the cost of administration and management.

The cost of the price subsidy is computed as the price discount allowed for rice and cooking oil multiplied by the subsidized quantity. The price discount is the difference between the market price and the subsidized price paid by the participating households. As shown in Table 30, this component accounted for about 84 percent of the total fiscal costs. To compensate retailers for added costs, the scheme offered an incentive of 7 percent of the gross sales of the program commodities to the accredited retailers. The reliance of the subsidy scheme on the private trade network for its procurement and distribution effectively saved the government the costs of the provision of warehousing, distribution outlets, and vehicles. The administrative overhead covered salaries and benefits for the extension workers and paraprofessional workers, the cost of travel of monitoring staff, salaries of central office project administration, office overhead, vehicles, and costs of printing the discount cards. It is difficult to estimate the cost of the nutrition education component separately from the administrative overhead for the subsidy operations because extension staff members performed both as subsidy monitoring officers and as nutrition educators. If person-hours were the mea-

---

[27] Stewart Blumenfeld et al., *PL 480 Title II: A Study of the Impact of Food Assistance Programs in the Philippines* (Washington, D.C.: U.S. Agency for International Development, 1982).

Table 30—Fiscal costs of the pilot food price subsidy scheme and their distribution

	Cost Per Month					Fiscal Cost Per Capita		
Province/ Subsidy	Subsidy Cost	Retailers' Incentive	Administrative Cost	Total Program Cost	Pilot Population Coverage	Monthly	Annually	Annually
		(pesos)				(pesos)		(U.S. $)
Abra								
Rice and oil	16,595	1,430	1,856	19,881	2,829	7.03	84.36	7.67
	(83.5)	(7.2)	(9.3)	(100.0)				
Antique								
Rice and oil	18,958	1,633	2,001	22,592	2,615	8.64	103.68	9.43
	(83.9)	(7.2)	(8.9)	(100.0)				
Antique								
Oil	4,941	221	1,634	6,796	1,797	3.78	45.36	4.12
	(72.7)	(3.3)	(24.0)	(100.0)				
South Cotabato								
Rice and oil	13,861	1,195	1,686	16,742	1,912	8.76	105.12	9.56
	(82.8)	(7.1)	(10.1)	(100.0)				
Average all areas	49,414	4,258	5,543	59,215	6,816	8.69	104.28	9.48
	(83.4)	(7.2)	(9.4)	(100.0)				

Source: Based on data collected by the International Food Policy Research Institute, Philippines National Nutrition Council, and the Philippines Ministry of Agriculture, "Pilot Food Subsidy Survey, 1983/84," Philippines.

Note: The numbers in parentheses are percentages of the total cost.

sure, however, the extension staff spent 60 percent of project time on subsidy monitoring and 40 percent for nutrition education.

Administrative costs accounted for 9.4 percent of the total cost of the pilot scheme. It is likely that in a national program, several layers of supervisory infrastructure, from the central offices down to the region, province, and village levels, would be necessary. This heavy supervisory infrastructure would likely put pressure on the implementing and coordinating agencies (in this case, the Ministry of Agriculture and the National Nutrition Council). Such burdens are associated with larger fiscal outlays for salaries and office overhead. It is estimated that these outlays would add 25 percent to the administrative costs shown in Table 30.

Cost-Effectiveness Measures

In estimating cost-effectiveness, three main factors are considered: the size of the net program benefits to intended beneficiaries, the extent of leakage associated with the different levels of targeting, and program costs. Estimates of the net effects of the scheme given in Chapter 8 are summarized in Table 31. It must be noted that these estimates are computed at the mean for all participating households and children within these households. The leakage issues have been discussed in Chapter 5 and will not be repeated here.

Cost-effectiveness indicators are developed in this study for alternative program goals. (Estimation procedures are described in Chapter 5.) Therefore, a program design with a goal to improve the nutrition of malnourished preschool children can be compared with a design where the goal is to improve the nutrition of all household members.

Fiscal Cost of Transferring U.S. $1.00

If the goal of the program is to efficiently transfer purchasing power, the fiscal cost of transferring U.S. $1.00 may be an appropri-

Table 31—Estimated net impact of the pilot subsidy scheme on food acquisition and nutrition

Variable	Model	Estimated Net Impact[a]
Household		
Food expenditure	Percent of total income	P 0.27 per AEU per day
	Dummy	P 0.34 per AEU per day
Calorie acquisition	Percent of total income	136 calories per AEU per day
	Dummy	138 calories per AEU per day
Individuals (preschoolers)		
Calorie intake	Percent of total income	31 calories per day
	Dummy	55 calories per day
Weight	Percent of total income	0.12 kilograms
	Dummy	0.14 kilograms

[a] The net impact is computed at the mean.

ate indicator of cost-effectiveness. As discussed in Chapter 5, this indicator is at best a crude measure of cost-effectiveness from a nutritional standpoint because several sources of leakage are present.

The cost of transferring U.S. $1.00 to all households participating in the subsidy scheme is calculated at U.S. $1.19 in 1984 prices (Table 32). This estimate assumes that all participating households are the target of the program. However, some recipient households are not nutritionally deficient. If the definition of the targets includes only those households that consume less than 80 percent of the recommended calories, the fiscal cost of transferring U.S. $1.00 rises to U.S. $1.63 under the assumption that program benefits accruing to households above the 80 percent cutoff constitutes a leakage. It is estimated from the consumption surveys that about 27 percent of the participating households were above the 80 percent cutoff line.

If the goal is to reach only those households with malnourished preschool children, the cost of transferring U.S. $1.00 increases by a factor of three because the extent of leakage from an untargeted program would be high. About one-third of the study households had at least one malnourished child. The rest of the households are considered nontarget under this assumption.

Fiscal Cost of Increasing Food Acquisition by 100 Calories per AEU per Day

If all households in the targeted villages are defined as program beneficiaries, it would cost U.S. $6.75 annually to increase the daily caloric intake by 100 calories per AEU (Table 32). This estimate is based on net impact, as it already accounts for substitution effects (see the discussion in Chapter 8). In order to bring the average calorie acquisition of households in the study areas to recommended levels, it would cost the government about U.S. $25 per AEU per year.

If the program is intended only for households with calorie acquisition of less than 80 percent of the recommended levels, then the subsidy received by households above this cutoff may be considered a leakage in a scheme targeted by area. Given the size of the leakage, it is estimated that it would cost U.S. $7.40 to increase the calorie intake of households below the 80 percent cutoff by 100 calories per AEU per day for one year. If the program goal is to reach only those households with malnourished preschool children, the annual fiscal cost would increase to U.S. $13.66 per AEU, inasmuch as two-thirds of the households do not have malnourished preschool chil-

Table 32—Cost-effectiveness indicators

Indicator	All Participating Households (H_1)	Households Consuming Less Than 80 Percent of RDA (H_2)	Households With Malnourished Children (H_3)	All Participating Preschool Children (C_1)	Preschool Children Consuming Less Than 80 Percent of RDA (C_2)	Malnourished Preschool Children (C_3)
				(U.S. $)		
Fiscal cost of transferring $1.00	1.19	1.63	3.61	n.a.	n.a.	n.a.
Annual fiscal cost per AEU of a net increase in food acquisition of 100 calories per AEU per day	6.75	7.40	13.66	n.a.	n.a.	n.a.
Annual fiscal cost per AEU of eliminating the calorie gap[a]	25.18	27.60	50.95	n.a.	n.a.	n.a.
Annual fiscal cost per preschooler of a net increase of 100 calories per individual preschool child per day	n.a.	n.a.	n.a.	26.00	45.12	74.41
Annual fiscal cost per preschooler of increasing the weight of preschool children by 1 kilogram[b]	n.a.	n.a.	n.a.	76.59	87.31	101.86

Notes: n.a. means not applicable. The adult equivalent unit (AEU) is a method used to convert the consumption of persons of different ages and sex into standard consumption units. Costs are given in 1984 prices.

[a] The mean calorie deficiency in the study households is estimated at 373 calories per AEU per day.

[b] The mean weight of children in the sample was 13.3 kilograms, which on average for all survey rounds is 86.9 percent of standard.

dren; hence, benefits to such households would be considered leakage.

Fiscal Cost of Increasing Preschoolers' Daily Calorie Consumption by 100 Calories

The analysis has shown that preschool children are at great nutritional risk because their share of the family food basket is small relative to their RDA. Hence, it is important to examine the range of cost required to raise their calorie intakes to a particular consumption level.

Based on the impact on calorie consumption for the preschool child derived from the individual demand equations in Chapter 5, it is estimated that it would cost the government U.S. $26 annually to increase the average daily intake of preschoolers by 100 calories per day per preschooler. This figure is roughly four times the cost of achieving the same level (100 calories) of benefit on average for all household members. The higher cost reflects the large share of additional household food consumption that will be captured by members other than preschoolers. The average calorie increment at the household level will also exceed the increment accruing to preschoolers within the same household because the distribution is uneven, and that will also be reflected in the cost.

Not all preschool children within the targeted villages are equally at risk of malnutrition. Some are more predisposed to the problem than others because of the varying amounts of calories consumed. If the scheme's objective is to reach only those children consuming less than 80 percent of RDA, then the benefits accruing to children above this cutoff are considered leakage. This translates to a higher cost: it is estimated that it would cost U.S. $45 per child to increase the daily calorie intake of preschoolers currently below the 80 percent cutoff by 100 calories for a one-year period.

If the program target is defined to include only the malnourished children, then the cost escalates to U.S. $74 per 100 calories because the leakage (benefits accruing to well-nourished children and other household members) is considerably higher.

Fiscal Cost of Increasing the Weight of Preschoolers

The expected effects of the scheme on child weight are summarized in Table 31. A net increment of 0.12 kilograms was the contribution of the scheme to the growth of children between 13-83 months. Such an impact represents 1.0 percent of the average body weight of the sample preschoolers. These estimates are based on actual ex-post data of a continuous and sustained level of participation in the subsidy scheme among the study children.

The incremental weight gain of children reported in Table 31 represents the average net impact produced by the scheme. In order to increase a child's weight by 1 kilogram, it would cost the government U.S. $76 annually. This assumes that all of the children in the study area are program targets. If the goal is to improve the weight of only malnourished children, the fiscal cost of increasing child weight by 1 kilogram increases to U.S. $101, since benefits derived by children who are not malnourished can be considered leakage.

The average weight of the preschool children in the sample was 13.3 kilograms, which is about 2.0 kilograms below the standard weight-for-age. Thus, the above increase of 1 kilogram would reduce the average gap by about one-half.

Improving Cost-Effectiveness

The preceding sections have clearly demonstrated that cost-effectiveness hinges on the method of targeting. The geographic-area targeting scheme that was used in the pilot subsidy scheme provides benefits to all households in the target areas irrespective of nutritional status and food deficiency. This implies that the cost-effectiveness of the scheme could be increased by targeting those households expected to be high-risk. Once the area is identified, a second level of screening of participants could target those households that need the subsidy. According to the cost-effectiveness indicators in Table 32, the cost of increasing the acquisition of a given amount of food by households with at least one malnourished preschooler could be reduced by half if the program were targeted to those households only.

The use of child weight as a targeting criterion may be feasible in the Philippine setting because of the extensive child weighing program carried out nationwide since 1975, called Operation *Timbang*. The use of growth monitoring for targeting would entail the additional cost of periodic weighing. However, this cost is very small and can be disregarded in cost-effectiveness estimates.

It is important to emphasize that targeting a price subsidy scheme is practical only at the household level. The presence of a malnourished child may be used to identify target households, but efforts to target the benefits of the scheme exclusively to the individual child are not likely to be successful.

Cost-Effectiveness Relative to Other Programs

It may be misleading to compare relative cost-effectiveness of alternative programs unless the context in which these programs are evaluated is based on a comparable set of objectives, targeting, coverage, timing of inputs, and duration of program and project organization. Given the state of the art in the evaluation of nutrition and health programs, including the shortage of data, any comparison, at best, can only detect general indications of relative cost-effectiveness.

Relative cost-effectiveness should be evaluated in terms of particular program goals. Hence, if the program goal is to deliver a certain number of calories, the measure of relative cost- effectiveness could give the cost of transferring, say, 1,000 calories. Alternatively, the measure could be given in terms of the cost to deliver U.S. $1.00 worth of subsidy if the concern is income transfer efficiency. However, these are crude measures from the point of view of nutrition because they do not account for leakages (see Chapter 5).

A more refined measure is the fiscal cost of a certain net increase in daily consumption by malnourished individuals. It should, however, be emphasized that in order to get meaningful results, calculations should be based on the net calorie impact, that is, net of substitution effects. However, few available program evaluations estimate substitution.

Cost-effectiveness indicators for several programs are reported in Table 33. The annual fiscal cost of a net increase in calorie consumption by 100 calories per day is available as a net figure only for the Philippine pilot subsidy scheme and for the Sri Lankan food stamp program.[28] The cost-effectiveness measures for other programs reported in Table 33 are estimated on the basis of gross calorie estimates of impact, and thus they overestimate the actual increase in consumption. The costs reported are not strictly comparable, although they give some guidance on relative cost-effectiveness. Except for the Philippine pilot subsidy and Sri Lankan food stamp program, the cost-effectiveness figures for the programs reported do not estimate leakage through sharing and substitution.

The results indicate that the Philippine pilot subsidy scheme is relatively more cost-effective than any of the programs listed in Table 33. The food stamp program in Sri Lanka is almost as cost-effective, but all the other programs are considerably less cost-effective. The cost of a gross transfer of 100 calories per person per day by any of the other programs is more than twice that of the Philippine program. However, these results must be interpreted in a proper context. Each of the programs cited has particular goals and methods of targeting; each uses different food commodities, and each

---

[28] Edirisinghe, *The Food Stamp Scheme in Sri Lanka*.

Table 33—Cost-effectiveness comparison with other programs

Program	Annual Cost Per Beneficiary	Food Transfers in Calories Per Person Per Day	Fiscal Cost to Deliver 1,000 Calories	Fiscal Cost to Deliver $1.00 Subsidy	Fiscal Cost of Transferring 100 Calories Per Day Per Person For One Year[a]	Fiscal Cost of a Net Increase of 100 Calories Per Day Per Person For One Year[b]
				(U.S. $)		
Philippines						
Pilot food price subsidy scheme, 1984	9.18	272 (gross)[a] 136 (net)[b]	0.11 (gross) 0.22 (net)	1.19	3.38	6.75
Sri Lanka						
Food stamp, 1982	8.60	228 (gross)[a] 98 (net)[b]	0.10 (gross) 0.24 (net)	n.a.	3.77	8.77
Brazil						
Food subsidy (PINS), 1980	21.32	300[a]	0.30	1.21	7.11	n.a.
Brazil						
Preschool feeding and nutrition education, 1980	46.48	500[a]	0.53	2.38	9.29	n.a.
Colombia						
Food subsidy, 1981	35.04	300[a]	0.79	1.58	11.68	n.a.
Indonesia						
Feeding program, 1982	56.01	n.a.	n.a.	2.48	. . .	n.a.
Mexico						
Milk subsidy, 1983	38.16	248[a]	n.a.	n.a.	15.38	n.a.
Tamil Nadu, India						
Weighing and feeding, 1982	33.10	300[a]	n.a.	1.74	11.03	n.a.
Philippines						
Mother and child health	31.00	n.a.	0.25	n.a.	. . .	n.a.
School feeding	11.50	n.a.	0.42	n.a.	. . .	n.a.
Day care	19.20	n.a.	n.a.	n.a.	. . .	n.a.
Mothercraft center	400.00	n.a.	n.a.	n.a.	. . .	n.a.

Sources: For Sri Lanka, Neville Edirisinghe, *The Food Stamp Scheme in Sri Lanka: Costs, Benefits, and Options for Modification,* Research Report 58 (Washington, D.C.: International Food Policy Research Institute, 1987); for Brazil, Colombia, Indonesia, and India, World Bank, Population, Health, and Nutrition Department, *Nutrition Review* (April 1984); for other programs in the Philippines, S. Blumenfeld et al., *PL 480 Title II: A Study of the Impact of a Food Assistance Program in the Philippines* (Washington, D.C.: U.S. Agency for International Development, 1982); and for Mexico, Eileen Kennedy, C. Overholt, and Lawrence Haddad, "Effect of a Milk Subsidy on Distribution of Benefits Within the Household," International Food Policy Research Institute, Washington, D.C., 1984.

Note: n.a. means not available.

[a] This is the amount of calories transferred if substitution is not accounted for.

[b] This is based on the marginal propensity to consume, accounting for substitution.

is implemented on a different scale. While only pilot programs have been implemented for the Philippine, Colombian, and Brazilian schemes, the Sri Lankan scheme has been in operation for a longer period on a national scale. The Tamil Nadu, India, program is narrowly targeted to malnourished children, while some of the other programs are not. Thus, the cost of transferring a certain amount of calories may not be an appropriate measure of the impact on nutrition.

As expected, the fiscal cost of transferring $1.00 worth of subsidy is determined largely by the degree of targeting. The Philippine scheme, which uses geographical area targeting, shows the lowest cost. The preschool feeding programs in Brazil, Indonesia, and India had the highest cost because these are the most tightly targeted among those reported in Table 33.

Among the factors that contribute to the relatively lower cost of delivery of the Philippine pilot subsidy scheme, the commodity mix is quite important. Besides being locally produced, rice and oil are the cheapest source of calories in the country, and they are available in almost all parts of the country. These foods are bought in raw form, unlike the expensive processed weaning foods used in the Colombian food subsidy program.

Another crucial factor is the substantially lower percentage of administrative costs—about 9.4 percent of the total cost. These costs are low because targeting by geographical area eliminates the burdensome and costly screening of beneficiaries found in some of the other programs. In addition, the administrative costs in the Philippine program are an add-on type of cost because the delivery system is built upon an already existing infrastructure of extension officers.

10

CONCLUSIONS

It is evident that the pilot subsidy scheme was successful in increasing food consumption among participating households. Although distribution of the additional food within the households favored adults, preschool children consumed more calories and showed improvement in their nutritional status. Increases in food consumption came mostly from the increases in purchasing power resulting from the price subsidies on rice and cooking oil. Furthermore, the marginal propensity to spend on food out of the real income embodied in the price subsidies appears to be considerably higher than the marginal propensity to spend on food out of other income. The lower oil prices resulted in substitution of oil for other commodities. Finally, the effects of the nutrition education component were positive and strong for children but weak on the household level.

The scheme resulted in net increases in calories acquired by households of 136-138 calories per AEU per day, which is about 7 percent of current calorie consumption; calorie consumption by preschoolers of 31-55 calories per child per day; and the weight of preschoolers of 0.12-0.14 kilograms. Eighty-four percent of the cost of the scheme was the subsidy itself. Administrative costs accounted for about 9 percent and the incentive payment to retailers to assure efficient distribution of subsidized food was about 7 percent.

The results of the assessment of cost-effectiveness can be summarized as follows. The fiscal cost of each U.S. $1.00 transferred to participating households is estimated to be U.S. $1.19. However, if only the transfers received by households with malnourished preschoolers are considered a benefit, whereas transfers received by other households are considered leakage, the cost increases to U.S. $3.61. Similarly, the annual cost of a net increase in calorie consumption of 100 calories per AEU per day among all households is estimated to be U.S. $6.75 per AEU, increasing to U.S. $13.66 if only food received by households with malnourished preschoolers is considered of interest to the scheme.

The annual cost of eliminating calorie deficiencies in the study population is estimated to be U.S. $25 per AEU. Adding 1 kilogram to the weight of each preschooler is estimated to cost U.S. $76 per year. If only weight gains among the malnourished are counted as benefits, the cost increases to U.S. $101 per year.

Comparisons with other programs show that the cost-effectiveness of the Philippine pilot subsidy scheme was extremely favorable, primarily because costs were kept low through geographical targeting based on growth monitoring, the use of existing private sector retail outlets for the distribution of subsidized foods, and the use and expansion of existing local bureaucratic structures.

If the sole goal of the scheme were to expand food consumption by households with malnourished preschoolers and to improve the nutritional status of these preschoolers, the cost-effectiveness of the scheme would be significantly improved by a two-step targeting procedure based on growth monitoring. The first step would be to identify target villages with a high concentration of underweight preschoolers. This was the approach used in this scheme. The second step would be to target individual households in the selected villages and to remove from the scheme those households that do not include preschoolers at high nutritional risk. According to the estimates here, a second targeting step would reduce the cost of providing benefits to high-risk preschoolers to less than one-half the cost of the scheme when untargeted within the village.

Low calorie adequacy rates among preschoolers, both in absolute terms and relative to the adequacy rates of adults, clearly justify focusing on this age group. However, adequacy rates of school-age children and adolescents were almost as low. Other studies have shown similar results.[29] If this finding is of general validity throughout the country, it raises serious questions about the usefulness of targeting nutrition programs to preschoolers alone. It might be more appropriate to use a two-step targeting procedure based on growth monitoring of all children, not just preschoolers.

A strong relationship between malnutrition and incomes is found in this study. Certain low-income occupational groups—landless farm workers, some wage earners, and tenant farmers, for example—are much more likely to be malnourished than others. This is primarily because their purchasing power is limited. Efforts to expand food consumption and improve the nutritional status of preschoolers in those groups through nutrition education are unlikely to be successful unless accompanied by expanded purchasing power.

Although nutrition education clearly plays a role in expanding food consumption by preschoolers, such expansion is more likely to come about as part of an overall increase in household food consumption. Efforts to reallocate an inadequate amount of food among household members so that preschoolers receive a larger share are unlikely to be successful in households operating under severe income constraints. Furthermore, such reallocation may endanger the survival of the household as a whole by further eroding the income-earning capabilities of economically active adult members who must have enough energy to work productively. However, as this study shows, nutrition education may be effective in assuring that a larger share of additional income is spent on food for the household members most at risk of malnutrition.

---

[29] Valenzuela, "Nutrient Distribution Within the Family"; and Aligaen and Florencio, "Intra-Householo Nutrient Distribution."

APPENDIX: SUPPLEMENTARY TABLES

Table 34—Regression results for household food expenditures and food acquisition

Independent Variable	Household Food Expenditures Per AEU Per Day		Household Calorie Acquisition Per AEU Per Day	
	Model A-1	Model A-2	Model B-1	Model B-2
Intercept	0.151 (1.39)	0.255 (2.37)	984.29 (14.89)	998.38 (15.35)
Log income per AEU (including subsidy)[a]	2.202 (57.82)	2.167 (56.72)	633.95 (27.38)	623.07 (27.01)
Subsidy in percent of income	0.032 (7.30)	. . .	8.94 (3.32)	. . .
Subsidy dummy	. . .	0.168 (4.96)	. . .	68.23 (3.35)
Log of household size	−0.051 (−7.83)	−0.054 (−7.70)	−5.92 (−1.40)	−5.98 (−1.41)
Education of husband	0.002 (0.49)	0.0004 (0.08)	−5.52) (−1.97)	−6.07 (−2.17)
Education of wife	0.017 (3.63)	0.016 (3.24)	−1.92 (−0.65)	−2.46 (−0.83)
Nutrition education dummy				
PNP[b]	0.023 (0.63)	0.062 (1.68)	−13.68 (−0.61)	−3.76 (−0.17)
Pilot[c]	−0.021 (−0.73)	−0.025 (−0.86)	22.67 (1.29)	21.86 (1.24)
Food assistance dummy	0.056 (1.86)	0.052 (1.73)	39.45 (2.16)	36.26 (1.98)
Percent women's income	0.001 (1.81)	0.001 (1.58)	−1.03 (−2.50)	−1.06 (−2.56)
Price of rice	0.006 (0.37)	0.006 (0.34)	−12.11 (−1.12)	−12.23 (−1.13)
Price of oil	0.012 (4.11)	0.004 (1.49)	−5.98 (−3.51)	−7.45 (−5.14)
Dummy for Antique Province	−0.059 (−1.47)	−0.069 (−1.71)	248.40 (10.18)	245.04 (10.04)
Dummy for South Cotabato Province	−0.135 (−3.75)	−0.110 (−3.05)	26.96 (1.23)	33.06 (1.52)
Own-farm dummy	0.013 (0.40)	0.009 (0.28)	98.46 (5.02)	98.79 (5.03)
Own-garden dummy	−0.035 (−1.06)	−0.009 (−0.28)	27.50 (1.36)	33.17 (1.66)
F	378.65	371.77	87.19	87.21
R^2	0.73	0.72	0.38	0.38

Notes: Figures in parentheses are t-ratios. The number of observations for each model was 2,509. Models A-1 and B-1 specify the subsidy variable in terms of the proportion of subsidy to total income; Models A-2 and B-2 specify the subsidy variable in terms of a zero-one dummy for the presence of subsidy.

[a] Income is approximated by total expenditures in all regressions.

[b] This dummy is for the Philippine Nutrition Program (PNP), a government program begun in 1974.

[c] This dummy is for the nutrition education program held in conjunction with the pilot food price subsidy study.

Table 35—Regression results for acquisition of rice, maize, oil, and fish

Independent Variable	Rice	Maize	Oil	Fish
		(calories/AEU/day)		
Intercept	785.36 (6.28)	319.63 (2.70)	112.72 (7.37)	82.13 (3.65)
Log income per AEU (including subsidy)[a]	333.13 (9.29)	−32.67 (−0.96)	28.55 (6.50)	39.64 (6.14)
Subsidy dummy	122.02 (3.89)	−104.79 (−3.53)	12.22 (3.18)	52.40 (9.27)
Log of household size	87.08 (2.03)	−6.23 (−0.15)	−24.97 (−4.76)	−40.08 (−5.19)
Education of husband	−8.94 (−2.07)	−1.71 (−0.42)	0.51 (0.97)	−2.51 (−3.22)
Education of wife	−6.50 (−1.43)	2.02 (0.47)	0.95 (1.71)	1.11 (1.36)
Nutrition education dummy				
PNP[b]	78.14 (2.88)	14.92 (0.58)	3.01 (0.91)	−4.27 (−0.88)
Pilot[c]	17.50 (0.51)	100.36 (3.10)	7.33 (1.75)	8.88 (1.44)
Food assistance dummy	105.44 (3.73)	−49.04 (−1.83)	−2.63 (−0.76)	8.41 (1.65)
Percent women's income	−0.59 (−0.92)	−1.22 (−2.04)	−0.01 (−0.16)	−0.22 (−1.90)
Price of rice	−5.81 (−0.35)	33.87 (2.15)	−1.62 (−0.79)	4.10 (1.37)
Price of maize	7.89 (0.65)	−11.12 (−0.97)	0.54 (0.36)	0.22 (0.10)
Price of oil	−10.66 (−4.76)	7.97 (3.77)	−4.22 (−15.41)	0.77 (1.90)
Price of fish	−3.90 (−1.23)	−5.51 (−1.83)	−0.43 (−1.09)	−7.57 (−13.20)
Dummy for Antique Province	331.52 (8.04)	−446.72 (−11.46)	−0.11 (−0.02)	101.19 (13.63)
Dummy for South Cotabato Province	62.12 (1.83)	−485.15 (−15.14)	10.99 (2.65)	9.22 (1.51)
Own-farm dummy	73.92 (2.45)	80.98 (2.83)	−1.65 (−0.45)	−7.07 (−1.30)
Own-garden dummy	13.15 (0.43)	61.95 (2.11)	−3.16 (−0.84)	−4.89 (−0.88)
F	21.56	23.41	36.95	65.01
R^2	0.15	0.16	0.23	0.34

Note: Figures in parentheses are t-ratios. The number of observations was 2,132.

[a] Income is approximated by total expenditures in all regressions.

[b] This dummy is for the Philippine Nutrition Program (PNP), a government program begun in 1974.

[c] This dummy is for the nutrition education program held in conjunction with the pilot food price subsidy study.

Table 36—Regression results for calorie intake of children aged 13 to 83 months

Independent Variable	Model A-1	Model A-2	Model B-1	Model B-2
Intercept	-948.70 (-4.78)	-843.35 (-4.40)	849.39 (-4.41)	-761.75 (-4.07)
Log income per AEU (including subsidy)[a]	140.39 (3.64)	129.05 (3.35)	. . .	. . .
Subsidy in percent of income	11.34 (3.31)	. . .	9.87 (2.87)	. . .
Subsidy dummy	. . .	100.27 (3.31)	. . .	88.35 (2.87)
Education of husband	-9.74 (-2.39)	-10.54 (-2.58)	-8.23 (-2.04)	-9.03 (-2.23)
Education of wife	-4.52 (-0.97)	-6.50 (-1.39)	-4.16 (-0.89)	-5.88 (-1.27)
Sex of child	122.02 (4.50)	124.95 (4.61)	122.49 (4.51)	125.06 (4.61)
Log age in months	395.59 (12.04)	391.57 (11.88)	395.70 (12.01)	392.18 (11.87)
Currently breastfed dummy	70.54 (1.72)	65.58 (1.60)	64.81 (1.58)	60.78 (1.48)
Past breastfed dummy	-75.53 (-1.91)	-71.10 (-1.81)	-72.90 (-1.84)	-69.33 (-1.76)
Nutrition education dummy				
PNP[b]	-42.74 (-1.19)	-45.75 (-1.27)	-36.16 (-1.01)	-39.20 (-1.09)
Pilot[c]	-55.97 (-1.90)	-55.48 (-1.88)	-62.14 (-2.10)	-61.21 (-2.07)
Child care time in hours of wife	-0.36 (-0.30)	-0.21 (-0.17)	0.16 (0.13)	0.25 (0.21)
Diarrhea dummy	-38.44 (-0.86)	-29.93 (-0.67)	-41.55 (-0.92)	-33.75 (-0.75)
Fever dummy	-79.9 (-2.50)	-68.32 (-2.15)	-67.55 (-2.12)	-58.18 (-1.84)
Food assistance dummy	20.69 (0.72)	20.14 (0.70)	4.97 (0.17)	5.71 (0.20)
Percent children below 6 years	1.47 (1.41)	1.00 (0.97)	1.31 (1.25)	0.91 (0.88)
Dummy for Antique Province	211.60 (4.73)	207.82 (4.65)	168.44 (3.79)	168.41 (3.79)
Dummy for South Cotabato Province	-37.98 (-1.06)	-29.04 (-0.81)	-52.03 (-1.45)	-43.13 (-1.21)
Birth order	-19.34 (-1.15)	-23.82 (-1.41)	-16.43 (-0.97)	-20.61 (-1.22)
Water quality dummy	55.24 (1.81)	43.06 (1.40)	60.94 (2.00)	49.91 (1.63)
Household size	-1.95 (0.11)	-4.05 (-0.23)	-10.19 (-0.59)	-7.50 (-0.43)

(continued)

Table 36—Continued

Independent Variable	Model A-1	Model A-2	Model B-1	Model B-2
Percent women's income	0.02 (0.02)	−0.13 (−0.14)	0.10 (0.11)	−0.04 (−0.04)
Price of rice	−68.60 (−1.91)	−45.87 (−1.37)	−63.36 (−1.76)	−43.71 (−1.31)
Price of cooking oil	−0.34 (−0.54)	−0.25 (−0.40)	−0.36 (−0.58)	−0.28 (−0.44)
Household calorie acquisition	. . .	. . .	0.10 (3.34)	0.09 (3.02)
F	15.84	15.84	15.69	15.68
R^2	0.43	0.43	0.43	0.43

Notes: Figures in parentheses are t-ratios. The number of observations for each model was 2,509. Models A-1 and B-1 specify the subsidy variable in terms of the proportion of subsidy to total income; Models A-2 and B-2 specify the subsidy variable in terms of a zero-one dummy for the presence of subsidy.

[a] Income is approximated by total expenditures in all regressions.

[b] This dummy is for the Philippine Nutrition Program (PNP), a government program begun in 1974.

[c] This dummy is for the nutrition education program held in conjunction with the pilot food price subsidy study.

Table 37—Regression results for weight of children aged 13 to 83 months

Independent Variable	Proportional Model	Zero-One Dummy Model
Intercept	−5.80 (−5.49)	−5.27 (−5.15)
Log income per AEU (including subsidy)[a]	0.68 (3.33)	0.68 (3.28)
Subsidy in percent of income	0.03 (1.44)	. . .
Subsidy dummy	. . .	−0.13 (−0.76)
Education of husband	0.0024 (0.11)	−0.0041 (0.19)
Education of wife	0.03 (1.04)	0.03 (1.04)
Sex of child	1.01 (7.00)	1.02 (7.05)
Log age in months	4.41 (25.11)	4.44 (25.16)
Currently breastfed dummy	−0.19 (−0.86)	−0.21 (−0.93)
Past breastfed dummy	−0.51 (−2.42)	−0.43 (−2.04)
Nutrition education dummy		
PNP[b]	0.02 (0.09)	0.05 (0.25)
Pilot[c]	0.25 (1.59)	0.21 (1.30)

(continued)

Table 37—Continued

Independent Variable	Proportional Model	Zero-One Dummy Model
Child care time in hours of wife	0.004 (0.06)	−0.00005 (−0.08)
Diarrhea dummy	−0.47 (−1.96)	−0.48 (−2.01)
Fever dummy	−0.16 (−0.91)	−0.12 (−0.73)
Food assistance dummy	0.0029 (0.02)	0.04 (0.25)
Percent children below 6 years	−0.0037 (−0.66)	−0.0051 (−0.92)
Dummy for Antique Province	−0.36 (−1.52)	−0.37 (−1.57)
Dummy for South Cotabato Province	−0.07 (−0.39)	−0.06 (−0.30)
Birth order	−0.35 (−3.89)	−0.35 (−3.88)
Water quality dummy	−0.48 (−2.96)	−0.47 (−2.83)
Household size	−0.44 (−4.73)	−0.44 (−4.62)
Price of rice	−0.04 (−0.23)	−0.21 (−1.17)
Price of cooking oil	−0.0046 (−1.37)	−0.0059 (−1.77)
F	56.51	56.27
R^2	0.72	0.72

Notes: Figures in parentheses are t-ratios. The number of observations was 509. The proportional model specifies the subsidy variable as a proportion of the subsidy to total income, whereas the dummy model specifies one for the presence of the subsidy, zero otherwise.

[a] Income is approximated by total expenditures in all regressions.

[b] This dummy is for the Philippine Nutrition Program (PNP), a government program begun in 1974.

[c] This dummy is for the nutrition education program held in conjunction with the pilot food price subsidy scheme.

Table 38—Regression results for weight as a percent of standard weight-for-age, children aged 13 to 83 months

Independent Variable	Proportional Model	Zero-One Dummy Model
Intercept	87.35 (12.45)	91.34 (13.42)
Log income per AEU (including subsidy)[a]	3.78 (2.77)	3.70 (2.70)
Subsidy in percent of income	0.21 (1.71)	. . .
Subsidy dummy	. . .	−0.70 (−0.65)

(continued)

Table 38—Continued

Independent Variable	Proportional Model	Zero-One Dummy Model
Education of husband	0.04 (0.25)	0.05 (0.33)
Education of wife	0.22 (1.34)	0.22 (1.31)
Sex of child	1.77 (1.84)	1.83 (1.90)
Log age in months	−5.47 (−4.69)	−5.27 (−4.49)
Currently breastfed dummy	0.40 (0.27)	0.27 (0.18)
Past breastfed dummy	−4.38 (−3.13)	−3.80 (−2.72)
Nutrition education dummy		
PNP[b]	0.20 (0.16)	0.41 (0.32)
Pilot[c]	2.26 (2.17)	1.94 (1.85)
Child care time in hours of wife	0.0076 (0.18)	0.0012 (0.03)
Diarrhea dummy	−3.35 (−2.10)	−3.44 (−2.15)
Fever dummy	−0.54 (−0.47)	−0.29 (−0.26)
Food assistance dummy	0.04 (0.04)	0.29 (0.29)
Percent children below 6 years	−0.002 (−0.05)	−0.01 (−0.35)
Dummy for Antique Province	−2.39 (−1.53)	−2.49 (−1.59)
Dummy for South Cotabato Province	−0.02 (−0.01)	0.12 (0.10)
Birth order	−1.91 (−3.19)	−1.91 (−3.19)
Water quality dummy	−2.94 (−2.71)	−2.84 (−2.59)
Household size	−2.60 (−4.17)	−2.54 (−4.06)
Price of rice	−0.30 (−0.23)	−0.92 (−0.77)
Price of cooking oil	−0.02 (−1.08)	−0.03 (−1.52)
F	3.66	3.52
R^2	0.14	0.14

Notes: Figures in parentheses are t-ratios. The number of observations was 509. The proportional model specifies the subsidy variable as a proportion of the subsidy to total income, whereas the dummy model specifies one for the presence of subsidy, zero otherwise.

[a] Income is approximated by total expenditures in all regressions.

[b] This dummy is for the Philippine Nutrition Program (PNP), a government program begun in 1974.

[c] This dummy is for the nutrition education program held in conjunction with the pilot food price subsidy scheme.

Table 39—Regression results for height as a percent of standard height-for-age, children aged 13 to 83 months

Independent Variable	Proportional Model	Zero-One Dummy Model
Intercept	100.56 (24.42)	100.81 (25.35)
Log income per AEU (including subsidy)[a]	1.11 (1.38)	1.16 (1.45)
Subsidy in percent of income	−0.03 (−0.37)	. . .
Subsidy dummy	. . .	−0.82 (−1.31)
Education of husband	0.13 (1.50)	0.13 (1.59)
Education of wife	0.09 (0.97)	0.11 (1.09)
Sex of child	0.47 (0.83)	0.46 (0.82)
Log age in months	−2.29 (−3.35)	−2.22 (−3.23)
Currently breastfed dummy	−0.53 (−0.63)	−0.53 (−0.63)
Past breastfed dummy	−1.51 (−1.84)	−1.40 (−1.72)
Nutrition education dummy		
PNP[b]	0.03 (0.04)	0.10 (0.13)
Pilot[c]	2.01 (3.29)	1.94 (3.17)
Child care time in hours of wife	0.01 (0.44)	0.008 (0.33)
Diarrhea dummy	−1.49 (−1.60)	−1.57 (−1.68)
Fever dummy	0.19 (0.28)	0.17 (0.25)
Food assistance dummy	−1.91 (−3.21)	−1.85 (−3.10)
Percent children below 6 years	0.04 (1.66)	0.04 (1.71)
Dummy for Antique Province	0.54 (0.59)	0.53 (0.58)
Dummy for South Cotabato Province	1.38 (1.87)	1.34 (1.83)
Birth order	−0.50 (−1.43)	−0.47 (−1.35)
Water quality dummy	−3.07 (−4.84)	−2.97 (−4.65)
Household size	−0.78 (−2.12)	−0.75 (−2.05)
Price of rice	−2.03 (−2.71)	−2.16 (−3.11)

(continued)

Table 39—Continued

Independent Variable	Proportional Model	Zero-One Dummy Model
Price of cooking oil	−0.02 (−1.20)	−0.02 (−1.33)
F	4.32	4.41
R^2	0.16	0.17

Notes: Figures in parentheses are t-ratios. The number of observations was 509. The proportional model specifies the subsidy variable as a proportion of the subsidy to total income, whereas the dummy model specifies one for the presence of the subsidy, zero otherwise.

[a] Income is approximated by total expenditures in all regressions.

[b] This dummy is for the Philippine Nutrition Program (PNP), a government program begun in 1974.

[c] This dummy is for the nutrition education program held in conjunction with the pilot food price subsidy scheme.

Table 40—Regression results for z-scores for weight-for-age, children aged 13 to 83 months

Independent Variable	Proportional Model	Zero-One Dummy Model
Intercept	−1.03 (−1.15)	−0.44 (−0.51)
Log income per AEU (including subsidy)[a]	0.42 (2.42)	0.41 (2.35)
Subsidy in percent of income	0.03 (1.97)	. . .
Subsidy dummy	. . .	−0.11 (−0.79)
Education of husband	0.0099 (0.54)	0.01 (0.62)
Education of wife	0.01 (0.02)	0.01 (0.64)
Sex of child	0.30 (2.46)	0.31 (2.52)
Log age in months	−0.60 (−4.05)	−0.57 (−3.82)
Currently breastfed dummy	−0.04 (−0.24)	−0.06 (−0.34)
Past breastfed dummy	−0.48 (−2.68)	−0.39 (−2.20)
Nutrition education dummy		
PNP[b]	−0.02 (−0.12)	0.01 (0.08)
Pilot[c]	0.28 (2.08)	0.23 (1.71)
Child care time in hours of wife	0.0069 (1.26)	0.0059 (1.07)
Diarrhea dummy	−0.34 (−1.66)	−0.35 (−1.71)

(continued)

Table 40—Continued

Independent Variable	Proportional Model	Zero-One Dummy Model
Fever dummy	−0.10 (−0.69)	−0.06 (−0.44)
Food assistance dummy	0.11 (0.89)	0.15 (1.18)
Percent children below 6 years	−0.004 (−0.77)	−0.005 (−1.11)
Dummy for Antique Province	−0.20 (−1.00)	−0.21 (−1.07)
Dummy for South Cotabato Province	0.19 (1.17)	0.21 (1.30)
Birth order	−0.21 (−2.89)	−0.22 (−2.80)
Water quality dummy	−0.40 (−2.89)	−0.39 (−2.75)
Household size	−0.29 (−3.60)	−0.28 (−3.47)
Price of rice	−0.010 (−0.006)	−0.17 (−1.12)
Price of cooking oil	−0.0009 (−0.31)	−0.0023 (−0.81)
F	3.15	2.98
R^2	0.12	0.12

Notes: Figures in parentheses are t-ratios. The number of observations was 509. The proportional model specifies the subsidy variable as a proportion of the subsidy to total income, whereas the dummy model specifies one for the presence of the subsidy, zero otherwise.

[a] Income is approximated by total expenditures in all regressions.

[b] This dummy is for the Philippine Nutrition Program (PNP), a government program begun in 1974.

[c] This dummy is for the nutrition education program held in conjunction with the pilot food price subsidy scheme.

Table 41—Regression results for z-scores for weight-for-height, children aged 13 to 83 months

Independent Variable	Proportional Model	Zero-One Dummy Model
Intercept	−2.00 (−2.27)	−1.46 (−1.71)
Log income per AEU (including subsidy)[a]	0.24 (1.40)	0.21 (1.25)
Subsidy in percent of income	0.04 (2.48)	. . .
Subsidy dummy	. . .	0.10 (0.75)
Education of husband	−0.02 (−0.95)	−0.02 (−0.97)
Education of wife	0.0076 (0.37)	0.004 (0.20)

(continued)

Table 41—Continued

Independent Variable	Proportional Model	Zero-One Dummy Model
Sex of child	0.14	0.16
	(1.21)	(1.29)
Log age in months	−0.09	−0.08
	(−0.63)	(−0.55)
Currently breastfed dummy	0.10	0.08
	(0.53)	(0.42)
Past breastfed dummy	−0.18	−0.13
	(−1.04)	(−0.70)
Nutrition education dummy		
PNP[b]	0.05	0.06
	(0.29)	(0.38)
Pilot[c]	−0.17	−0.20
	(−1.29)	(−1.51)
Child care time in hours of wife	−0.0029	−0.003
	(−0.54)	(−0.59)
Diarrhea dummy	−0.13	−0.12
	(−0.63)	(−0.60)
Fever dummy	−0.13	−0.09
	(−0.91)	(−0.61)
Food assistance dummy	0.39	0.41
	(3.03)	(3.18)
Percent children below 6 years	−0.0079	−0.01
	(−1.70)	(−2.10)
Dummy for Antique Province	−0.52	−0.53
	(−2.64)	(−2.70)
Dummy for South Cotabato Province	−0.29	−0.27
	(−1.87)	(−1.68)
Birth order	−0.16	−0.17
	(−2.13)	(−2.21)
Water quality dummy	0.26	0.25
	(1.92)	(1.82)
Household size	−0.18	−0.18
	(−2.36)	(−2.31)
Price of rice	−0.43	−0.28
	(−2.68)	(−1.87)
Price of cooking oil	−0.0001	−0.0009
	(−0.04)	(−0.33)
F	2.87	2.58
R^2	0.11	0.10

Notes: Figures in parentheses are t-ratios. The number of observations was 509. The proportional model specifies the subsidy variable as a proportion of the subsidy to total income, whereas the dummy model specifies one for the presence of the subsidy, zero otherwise.

[a] Income is approximated by total expenditures in all regressions.

[b] This dummy is for the Philippine Nutrition Program (PNP), a government program begun in 1974.

[c] This dummy is for the nutrition education program held in conjunction with the pilot food price subsidy scheme.

BIBLIOGRAPHY

Alderman, Harold. *The Effect of Food Price and Income Changes on the Acquisition of Food by Low-Income Households.* Washington, D.C.: International Food Policy Research Institute, 1986.

Alderman, Harold, and von Braun, Joachim. *The Effects of the Egyptian Food Ration and Subsidy System on Income Distribution and Consumption.* Research Report 45. Washington, D.C.: International Food Policy Research Institute, 1984.

Aligaen, Melba B., and Florencio, Cecilia B. "Intra-Household Nutrient Distribution and Adequacy of Food and Nutrition Intake of Filipino Urban Households." *Philippine Journal of Nutrition* (January-March 1980): 11-19.

Behrman, Jere, and Wolfe, Barbara. "More Evidence on Nutrition Demand: Income Seems Overrated and Women's Schooling Underemphasized." *Journal of Development Economics* 14 (January-February 1984): 105-128.

Benus, J; Kmenta, J.; and Shapiro, H. "The Dynamics of Household Budget Allocation to Food Expenditures." *Review of Economics and Statistics* 58 (No. 2, 1976): 129-138.

Blumenfeld, Stewart; Flores, Maria B.; Mack, M.; Norton; and Pooley. *PL 480 Title II: A Study of the Impact of Food Assistance Programs in the Philippines.* Washington, D.C.: U.S. Agency for International Development, 1982.

Bouis, Howarth. "Rice Policy in the Philippines." Ph.D. dissertation, Stanford University, 1982.

Carloni, Alice S. "Sex Disparities in the Distribution of Food Within Rural Households." *Food and Nutrition* 7 (1981): 3-12.

Deaton, Angus, and Muellbauer, John. *Economics and Consumer Behavior.* New York: Cambridge University Press, 1980.

Edirisinghe, Neville. *The Food Stamp Scheme in Sri Lanka: Costs, Benefits, and Options for Modification.* Research Report 58. Washington, D.C.: International Food Policy Research Institute, 1987.

Evenson, Robert E.; Popkin, Barry M.; and Quizon, Elizabeth K. "Nutrition, Work and Demographic Behavior in Rural Philippine Households." In *Rural Household Studies in Asia.* Edited by Hans P. Binswanger, Robert Evenson, Cecilia A. Florencio, and Benjamin White. Singapore: Singapore University Press, 1980.

Fraker, Thomas; Devaney, Barbara; and Cavin, Edward. "An Evaluation of the Effect of Cashing Out Food Stamps on Food Expenditures." *American Economic Review* 76 (May 1986): 230-234.

Friedman, Milton. *A Theory of the Consumption Function.* Princeton: Princeton University Press, 1957.

Hassan, Nazmul, and Ahmad, Kamaluddin. "Intra-Familial Distribution of Food in Rural Bangladesh." *Food and Nutrition Bulletin* 6 (No. 4, 1984): 34-42.

Hymans, S., and Shapiro, H. "The Allocation of Household Income to Food Consumption." *Five Thousand American Families—Patterns of Economic Progress,* Vol. II. Edited by J. Morgan. Ann Arbor: University of Michigan Press, 1975.

Knudsen, Odin K., and Scandizzo, Pasquale L. *Nutrition and Food Needs in Developing Countries.* Staff Working Paper 328. Washington, D.C.: World Bank, 1979.

Kumar, Shubh. *The Impact of Subsidized Rice on Food Consumption and Nutrition in Kerala.* Research Report 5. Washington, D.C.: International Food Policy Research Institute, 1979.

Mellor, John W. "Food Aid and Nutrition." *American Journal of Agricultural Economics* 62 (December 1980): 979-983.

Philippines, Food and Nutrition Research Institute. *Publication No. 75.* Manila: FNRI, 1977.

Philippines, Food and Nutrition Research Institute, National Science and Technology Authority. *Second Nationwide Nutrition Survey, Philippines, 1982.* Manila: NSTA, 1984.

Philippines, Food and Nutrition Research Institute and National Nutrition Council. *Recommended Dietary Allowances for Filipinos.* Manila: FNRI, 1976.

Philippines, Ministry of Agriculture, National Nutrition Council and the National Economic and Development Authority. *The Philippine Food and Nutrition Plan for the 80s.* Manila: Ministry of Agriculture, 1980.

Philippines, National Economic and Development Authority. *Philippine Statistical Yearbook.* Manila: NEDA, 1985.

Philippines, National Nutrition Council, Nutrition Research Committee. *Philippine Recommended Dietary Allowances, Part I, Nutrients.* Manila: National Nutrition Council, 1976.

Pimoz, E., and Viteri, F. "Understanding Health and Nutrition Behavior Through the Study of Household Decision-Making and Intra-Household Resource Distribution." Washington, D.C.: Pan-American Health Organization, 1983.

Pinstrup-Andersen, Per. "An Analytical Framework for Assessing Nutritional Effects of Policies and Programs." In *Food Policy.* Edited by Charles K. Mann and Barbara Huddleston. Bloomington: Indiana University Press, 1985.

Pinstrup-Andersen, Per, ed. *Consumer-Oriented Food Subsidies: Costs, Benefits, and Policy Options for Developing Countries.* Baltimore: Johns Hopkins University Press for International Food Policy Research Institute, forthcoming.

Prais, S. J., and Houthakker, H. S. *The Analysis of Family Budgets.* New York: Cambridge University Press, 1971.

Reutlinger, Shlomo, and Katona-Apte, Judith. *The Nutritional Impact of Food Aid: Criteria for the Selection of Cost-Effective Foods.* Washington, D.C.: World Bank, 1984.

Sahn, David E. "Malnutrition and Food Consumption in Sri Lanka: An Analysis of Changes from 1969 to 1982." International Food Policy Research Institute, Washington, D.C., 1986 (mimeographed).

Senauer, Ben; Garcia, Marito; and Jacinto, Elizabeth. "Determinants of Intrahousehold Allocation of Food in Rural Philippines." *American Journal of Agricultural Economics* (forthcoming, February 1988).

Senauer, Ben, and Young, Nathan. "The Impact of Food Stamps on Expenditures: Rejection of the Traditional Model." *American Journal of Agricultural Economics* 68 (February 1986): 37-43.

Silverio, Simeon G. *The Neighborhood Sari-Sari Store.* Institute of Philippine Culture Poverty Series 2. Quezon City, Philippines: Ateneo de Manila University, 1975.

Trairatvorakul, Prasarn. *The Effects on Income Distribution and Nutrition of Alternative Rice Price Policies in Thailand.* Research Report 46. Washington, D.C.: International Food Policy Research Institute, 1984.

Valenzuela, Rosario. "A Study on Nutrient Distribution within the Family and Factors Affecting Nutrient Intake." University of the Philippines, Diliman, 1977 (mimeographed).

Valenzuela, Rosario; Florencio, Cecilia; and Guthrie, H. "Distribution of Nutrients Within the Family." *Nutrition Report International* 19 (No. 4, 1979).

West, Donald A., and Price, David W. "The Effects of Income, Assets, Food Programs, and Household Size on Food Consumption." *American Journal of Agricultural Economics* 58 (1976): 725-730.

Wolfe, Barbara, and Behrman, Jere. "Determinants of Child Mortality, Health, and Nutrition in a Developing Country." *Journal of Development Economics* 11 (1982): 163-193.

RECENT IFPRI RESEARCH REPORTS (continued)

41 *RURAL GROWTH LINKAGES: HOUSEHOLD EXPENDITURE PATTERNS IN MALAYSIA AND NIGERIA,* September 1983, by Peter B. R. Hazell and Ailsa Röell

40 *FOOD SUBSIDIES IN EGYPT: THEIR IMPACT ON FOREIGN EXCHANGE AND TRADE,* August 1983, by Grant M. Scobie

39 *THE WORLD RICE MARKET: STRUCTURE, CONDUCT, AND PERFORMANCE,* June 1983, by Ammar Siamwalla and Stephen Haykin

38 *POLICY MODELING OF A DUAL GRAIN MARKET: THE CASE OF WHEAT IN INDIA,* May 1983, by Raj Krishna and Ajay Chhibber

37 *SERVICE PROVISION AND RURAL DEVELOPMENT IN INDIA: A STUDY OF MIRYALGUDA TALUKA,* February 1983, by Sudhir Wanmali

36 *AGRICULTURE AND ECONOMIC GROWTH IN AN OPEN ECONOMY: THE CASE OF ARGENTINA,* December 1982, by Domingo Cavallo and Yair Mundlak

35 *POLICY OPTIONS FOR THE GRAIN ECONOMY OF THE EUROPEAN COMMUNITY: IMPLICATIONS FOR DEVELOPING COUNTRIES,* November 1982, by Ulrich Koester

34 *EGYPT'S FOOD SUBSIDY AND RATIONING SYSTEM: A DESCRIPTION,* October 1982, by Harold Alderman, Joachim von Braun, and Sakr Ahmed Sakr

33 *AGRICULTURAL GROWTH AND INDUSTRIAL PERFORMANCE IN INDIA,* October 1982, by C. Rangarajan

32 *FOOD CONSUMPTION PARAMETERS FOR BRAZIL AND THEIR APPLICATION TO FOOD POLICY,* September 1982, by Cheryl Williamson Gray

31 *SUSTAINING RAPID GROWTH IN INDIA'S FERTILIZER CONSUMPTION: A PERSPECTIVE BASED ON COMPOSITION OF USE,* August 1982, by Gunvant M. Desai

30 *INSTABILITY IN INDIAN FOODGRAIN PRODUCTION,* May 1982, by Peter B. R. Hazell

29 *GOVERNMENT POLICY AND FOOD IMPORTS: THE CASE OF WHEAT IN EGYPT,* December 1981, by Grant M. Scobie

28 *GROWTH AND EQUITY: POLICIES AND IMPLEMENTATION IN INDIAN AGRICULTURE,* November 1981, by J. S. Sarma

27 *AGRICULTURAL PRICE POLICIES UNDER COMPLEX SOCIOECONOMIC AND NATURAL CONSTRAINTS: THE CASE OF BANGLADESH,* October 1981, by Raisuddin Ahmed

26 *FOOD SECURITY IN THE SAHEL: VARIABLE IMPORT LEVY, GRAIN RESERVES, AND FOREIGN EXCHANGE ASSISTANCE,* September 1981, by John McIntire

25 *INSTABILITY IN INDIAN AGRICULTURE IN THE CONTEXT OF THE NEW TECHNOLOGY,* July 1981, by Shakuntla Mehra

24 *THE EFFECTS OF EXCHANGE RATES AND COMMERCIAL POLICY ON AGRICULTURAL INCENTIVES IN COLOMBIA: 1953-1978,* June 1981, by Jorge García García

23 *GOVERNMENT EXPENDITURES ON AGRICULTURE IN LATIN AMERICA,* May 1981, by Victor J. Elías

Marito Garcia has been a research fellow at the International Food Policy Research Institute since 1982. Per Pinstrup-Andersen was a research fellow at IFPRI from 1980 to 1986. He now directs the Cornell University Nutritional Surveillance Program.

RECENT IFPRI RESEARCH REPORTS

60 *POPULATION POLICY AND INDIVIDUAL CHOICE: A THEORETICAL INVESTIGATION,* June 1987, by Marc Nerlove, Assaf Razin, and Efraim Sadka

59 *PRODUCTION INCENTIVES IN PHILIPPINE AGRICULTURE: EFFECTS OF TRADE AND EXCHANGE RATE POLICIES,* May 1987, by Romeo M. Bautista

58 *THE FOOD STAMP SCHEME IN SRI LANKA: COSTS, BENEFITS, AND OPTIONS FOR MODIFICATION,* March 1987, by Neville Edirisinghe

57 *CEREAL FEED USE IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 2000,* December 1986, by J. S. Sarma

56 *THE EFFECTS OF TRADE AND EXCHANGE RATE POLICIES ON AGRICULTURE IN ZAIRE,* November 1986, by Tshikala B. Tshibaka

55 *THE EFFECTS OF TRADE AND EXCHANGE RATE POLICIES ON AGRICULTURE IN NIGERIA,* October 1986, by T. Ademola Oyejide

54 *WEATHER AND GRAIN YIELDS IN THE SOVIET UNION,* September 1986, by Padma Desai

53 *REGIONAL COOPERATION TO IMPROVE FOOD SECURITY IN SOUTHERN AND EASTERN AFRICAN COUNTRIES,* July 1986, by Ulrich Koester

52 *FOOD IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 2000,* June 1986, by Leonardo A. Paulino

51 *DETERMINANTS OF AGRICULTURAL POLICIES IN THE UNITED STATES AND THE EUROPEAN COMMUNITY,* November 1985, by Michel Petit

50 *GOVERNMENT EXPENDITURES ON AGRICULTURE AND AGRICULTURAL GROWTH IN LATIN AMERICA,* October 1985, by Victor J. Elias

49 *LIVESTOCK PRODUCTS IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 1990 AND 2000,* April 1985, by J. S. Sarma and Patrick Yeung

48 *RURAL HOUSEHOLD USE OF SERVICES: A STUDY OF MIRYALGUDA TALUKA, INDIA,* March 1985, by Sudhir Wanmali

47 *EVOLVING FOOD GAPS IN THE MIDDLE EAST/NORTH AFRICA: PROSPECTS AND POLICY IMPLICATIONS,* December 1984, by Nabil Khaldi

46 *THE EFFECTS ON INCOME DISTRIBUTION AND NUTRITION OF ALTERNATIVE RICE PRICE POLICIES IN THAILAND,* November 1984, by Prasarn Trairatvorakul

45 *THE EFFECTS OF THE EGYPTIAN FOOD RATION AND SUBSIDY SYSTEM ON INCOME DISTRIBUTION AND CONSUMPTION,* July 1984, by Harold Alderman and Joachim von Braun

44 *CONSTRAINTS ON KENYA'S FOOD AND BEVERAGE EXPORTS,* April 1984, by Michael Schluter

43 *CLOSING THE CEREALS GAP WITH TRADE AND FOOD AID,* January 1984, by Barbara Huddleston

42 *THE EFFECTS OF FOOD PRICE AND SUBSIDY POLICIES ON EGYPTIAN AGRICULTURE,* November 1983, by Joachim von Braun and Hartwig de Haen

(continued on inside back cover)

International Food Policy Research Institute
1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 USA

RESEARCH REPORT

62

- R5620 - 1.7F 12/87 -

AGRICULTURAL RESEARCH IN NEPAL: RESOURCE ALLOCATION, STRUCTURE, AND INCENTIVES

Ram P. Yadav

September 1987

The **International Food Policy Research Institute** was established in 1975 to identify and analyze alternative national and international strategies and policies for meeting food needs in the world, with particular emphasis on low-income countries and on the poorer groups in those countries. While the research effort is geared to the precise objective of contributing to the reduction of hunger and malnutrition, the factors involved are many and wide-ranging, requiring analysis of underlying processes and extending beyond a narrowly defined food sector. The Institute's research program reflects worldwide interaction with policymakers, administrators, and others concerned with increasing food production and with improving the equity of its distribution. Research results are published and distributed to officials and others concerned with national and international food and agricultural policy.

The Institute receives support as a constituent of the Consultative Group on International Agricultural Research from a number of donors including the United States, the World Bank, Japan, Canada, the United Kingdom, the Netherlands, Australia, the Ford Foundation, Italy, Norway, the Federal Republic of Germany, India, the Philippines, Switzerland, Belgium, and the People's Republic of China. In addition, a number of other governments and institutions contribute funding to special research projects.

Board of Trustees

Dick de Zeeuw
Chairman, Netherlands

Ralph Kirby Davidson
Vice Chairman, U.S.A.

Eliseu Roberto de Andrade Alves
Brazil

Yahia Bakour
Syria

Ivan L. Head
Canada

Dharma Kumar
India

Anne de Lattre
France

James R. McWilliam
Australia

Philip Ndegwa
Kenya

Saburo Okita
Japan

Sukadji Ranuwihardjo
Indonesia

Theodore W. Schultz
U.S.A.

Leopoldo Solís
Mexico

M. Syeduzzaman
Bangladesh

Charles Valy Tuho
Côte d'Ivoire

John W. Mellor, Director
Ex Officio, U.S.A.

AGRICULTURAL RESEARCH IN NEPAL: RESOURCE ALLOCATION, STRUCTURE, AND INCENTIVES

Ram P. Yadav

Research Report 62
International Food Policy Research Institute
September 1987

Copyright 1987 International Food Policy
Research Institute.

All rights reserved. Sections of this report may be reproduced without the express permission of but with acknowledgment to the International Food Policy Research Institute.

Library of Congress Cataloging
in Publication Data

Yadav, Ram P., 1947-
Agricultural research in Nepal.

(Research report ; 62)
"September 1987."
Bibliography: p. 75.
1. Agriculture—Research—Nepal. I. Title.
II. Series: Research report (International Food Policy Research Institute) ; 62.

S542.N35Y33 1987 630'.720549'6 87-26295
ISBN 0-89629-064-6

CONTENTS

Foreword
1. Summary 9
2. Introduction 12
3. Agricultural Plan, Policy, and Performance—A Review 14
4. Institutional Development of Agricultural Research 25
5. Allocation of Financial and Personnel Resources for Research 38
6. Research Management and Incentives 50
7. Agricultural Research Priorities and Structure: Some Concluding Observations 59
Appendix 1: Supplementary Tables 65
Appendix 2: Methodology for Determining Growth Rates and Decomposition of Growth Trends 74
Bibliography 75

TABLES

1. Farm size and distribution of cultivated landholdings, 1981 15
2. Annual growth rate of cereal crop area, production, and yield, 1961/62-1980/81 17
3. Per capita food production, 1970/71-1980/81 18
4. Annual growth rate of cereal crop area, production, and yield, by region, 1970/71-1980/81 19
5. Annual growth rate of cash crop area, production, and yield, 1961/62-1980/81 20
6. Annual growth rates (compound) of agricultural production and its components, 1961/62-1980/81 21
7. Annual consumption of chemical fertilizer, 1970/71-1980/81 22
8. Area under high-yielding varieties (HYVs) of wheat, paddy, and maize, 1970/71-1980/81 23
9. Agricultural sector budget expenditures, 1970/71-1980/81 38
10. Budget expenditures on agricultural research and extension and other agricultural items, 1970/71-1980/81 39
11. Agricultural research expenditures, by discipline, 1970/71-1980/81 39
12. Agricultural research expenditures on hill, Tarai, and disciplinary research, 1970/71-1980/81 40
13. Agricultural research expenditures, by region and discipline, 1970/71-1980/81 41
14. Agricultural research expenditure as a share of agricultural GDP and of expenditures on development, agricultural sector, and agriculture, 1970/71-1980/81 41
15. Proposed expenditures for agricultural research and extension in the Sixth Five-Year Plan (1980-85) 42
16. Budgeted and actual research expenditures, 1978/79-1980/81 average 43
17. Average total research expenditure and recurrent expenditure, by commodity, 1978/79-1980/81 44
18. Budgeted and actual research expenditure as a share of agricultural GDP and of expenditures on development, the agricultural sector, and agriculture, 1978/79-1980/81 average 45
19. Total trained agricultural personnel, 1979/80 46
20. Trained personnel in agricultural research, extension, and education, 1979/80 48
21. Trained personnel in agricultural research, by rank and research category, 1979/80 48
22. Trained officers in agricultural research, by education and discipline, 1979/80 48

23. Classification of 120 research officers by sex, education, and number of years and transfers in service 50
24. Researchers' opinions of promotion rules 51
25. Researchers' ratings of job-satisfaction criteria 51
26. Amount of researchers' time spent on research 52
27. Researchers engaged in nonresearch work 52
28. Researchers' opinions of allocation of work time 52
29. Researchers' reasons for accepting present positions 52
30. Researchers' preferences for different positions 53
31. Number of researchers' projects and publications, 1976-81 53
32. Initiators of researchers' current experiments 53
33. Researchers' ranking of constraints to research 54
34. Researchers' rating of research guidance from supervisor 54
35. Researchers' preferred organization of research bodies 54
36. Researchers' desire for further training 54
37. Share of various sectors in development expenditures during five-year plans, 1965-85 65
38. Total GDP, agricultural GDP, and budget expenditures, 1970/71-1980/81 65
39. High-yielding cereal varieties released in Nepal, 1959-85 66
40. Foreign-aided projects that partly support agricultural research activities in Nepal, 1982 67
41. Crop research budget expenditures, 1970/71-1980/81 68
42. Livestock development budget expenditures, 1970/71-1980/81 69
43. Horticultural farm budget expenditures, 1970/71-1980/81 70
44. Fisheries development budget expenditures, 1970/71-1980/81 71
45. Food and agricultural input research budget expenditures, 1970/71-1980/81 71
46. Socioeconomic and marketing research budget expenditures, 1975/76-1980/81 72
47. Classification of budget expenditures 72
48. Trained personnel in agriculture, by institution, 1983 73
49. Trained personnel in the Ministry of Agriculture and its parastatals, by discipline, 1983 73

ILLUSTRATIONS

1. Organization chart of the Department of Agriculture, 1972/73 28
2. Organization chart of the Department of Agriculture, 1982 30
3. Locations of agricultural research stations and farms 31

FOREWORD

If agriculture is to play a major role in economic development, the productivity of the factors of production used in agriculture (land, labor, and capital) must be increased. Because of the limited land base, the development of new technologies by means of agricultural research is essential to achieving these productivity increases. Ram Yadav's analysis of Nepal's agricultural research system shows dramatically that only a strong national research system can effectively adopt or adapt such technologies from the research of other countries.

In the period analyzed in this study, the government of Nepal and the foreign assistance community spent large sums on regional development programs and agricultural extension. In the developing world generally, and neighboring countries in particular, new agricultural technologies were developed and successfully applied, raising both aggregate growth rates in agriculture and aggregate yields of crops. But in Nepal, compared to much of the rest of the world, yield increases were slight and in many cases even negative. During this time, neither the government of Nepal nor the foreign assistance donors were attempting to develop a research system comparable to the systems developed decades earlier in other Asian countries.

The same inattention to agricultural research and the concomitant poor growth are apparent in the countries of Sub-Saharan Africa. Thus it is instructive to examine this Asian case in detail, not only for the direct lessons to Nepal, but also for the opportunities it offers for comparative analysis.

The interest of the International Food Policy Research Institute (IFPRI) in the issues raised by the case study of Nepal derives not only from our broad concerns with the role of agriculture in economic development (development strategy), but also from the point of view of optimal technology development policy. What is the relative emphasis needed on research—with what assumptions about how research resources can be made productive?

IFPRI has recently completed a case study of Nigeria as well as this one on Nepal. Comparative analyses of several African countries are in progress, and an integrative analysis will be prepared relating these analyses more broadly to technology policy.

For now, Ram Yadav's analysis suggests the need for a much higher level of budgetary support to agricultural research than has been the case in Nepal, a much larger training effort sustained for many years to provide the Ph.D. leadership essential to good research and to linking with other national and international systems, an effective overall coordinating and priority-setting council for agricultural research, and an incentive system that fosters stability of personnel and continuity of research. A large number of detailed recommendations also emerge from this analysis.

We are grateful to the International Development Research Centre (IDRC) for sponsoring Ram Yadav at IFPRI under an IDRC Professional Development Award that enabled the completion of this report; to Ram Yadav; and to the International Centre for Integrated Mountain Development (ICIMOD), where he is now deputy director, for his time to accomplish this valuable research at IFPRI.

John W. Mellor

Washington, D.C.
September 1987

ACKNOWLEDGMENTS

The author is grateful to the International Development Research Centre (IDRC), Canada, which enabled him to undertake this study at IFPRI under the IDRC Professional Development Award.

He is deeply indebted to John W. Mellor, from whom he received encouragement and advice during this study and helpful comments at various stages of the draft.

Limitations of space make it impossible to acknowledge by name all those who helped the author during the writing of this report. However, the author feels especially indebted to Dayanatha Jha, who helped to complete this report by discussion, comment, and criticism.

J. S. Sarma, Raisuddin Ahmed, Gunvant Desai, Chandra Ranade, Peter Oram, Wayne Freeman, and A. N. Bhattarai also contributed significantly to the final draft of this report.

In addition, the author appreciates the help of colleagues at the Agricultural Projects Services Centre (APROSC) for their assistance in data collection and of those Nepalese researchers who volunteered their time to answer the author's questionnaire.

1

SUMMARY

Agriculture, which is the predominant sector of Nepal's economy, provides the major source of livelihood to 94 percent of the population and therefore must take the lead in Nepal's development. Accordingly, the agricultural sector received high priority for resource allocation in the three five-year plans between 1970 and 1985. Nevertheless, the achievements in agriculture have remained behind the targets in all development plans. Agricultural productivity has remained stagnant in most crops and has declined in maize and millet. From 1970/71 to 1980/81, gross foodgrain production increased at an annual rate of less than 1 percent, while the population increased at about 2.7 percent. This discrepancy resulted in a decline in the per capita net foodgrain production from 185 kilograms in 1970/71 to 160 kilograms in 1980/81. Production and productivity declined much faster in the hills and mountains than in the more fertile Tarai plain during this period.

The decomposition of agricultural growth trends carried out in this study indicates that increase of cropped area is the dominating factor in the growth of agricultural output. Overall, productivity decreased between 1961/62 and 1980/81, although it improved in the second half of that period, probably because of adoption of improved technology. In the same 20-year period, most cash crops showed greater production increases than did cereal crops. Although traditionally a food-exporting country, Nepal is on the verge of importing foodgrains to feed its rapidly growing population.

The objectives of this study include an assessment of national policy in Nepal toward improving agricultural technology, and an analysis of the institutional factors that affect agricultural production. The study is primarily based on secondary data and official documents that enabled an examination of the trends in agricultural production and productivity and of the resource allocation patterns from 1970/71 to 1980/81. In addition, 120 researchers at various levels were interviewed to learn their views regarding their status, authority, responsibility, performance, evaluation, salary, promotion rules, training needs, guidance and supervision, and research facilities.

In terms of financial resource allocation, the share of expenditure for the agricultural sector (which comprises agriculture, irrigation, forestry, land reform, and cadastral survey) increased over several five-year plans. However, the growth rate of the budget for the agriculture component alone was lower than that for other components of the agricultural sector. The real expenditure in agricultural research from 1970/71 to 1980/81 increased at about 4 percent annually, compared with 7 percent in agricultural extension and 14 percent in agricultural support services and other programs. The share of agricultural research expenditure as a percentage of agricultural GDP remained almost constant at around 0.22 percent during that period.

The low priority accorded to agricultural research is reflected in the substantial decline of agricultural research expenditure as a proportion of the agriculture budget (from 32 percent in 1970/71 to 14 percent in 1980/81). The proposed research expenditure for the Sixth Five-Year Plan (1980-85) showed a further decline to only 8 percent. Also, the money spent and manpower engaged in the disciplinary and commodity sections, research stations and farms, and commodity research programs were not all utilized for real research purposes. The three-year (1978/79-1980/81) average of the total research budget expenditure was about Rs 35.4 million, whereas the expenditure on actual research work was estimated to be only Rs 12.5 million, about 35 percent of the total. The remaining 65 percent was used for such nonresearch activities as producing and distributing improved seeds, plants, livestock, and fingerlings on farms; providing training to local farmers and extension workers; and providing technical assistance to farmers. On this basis, research investments represent only 0.1 percent of agricultural GDP in Nepal.

Of the total estimated actual research expenditure between 1970/71 and 1980/81, crop research constituted about 70 percent and 30 percent was directed to livestock (7 percent), horticulture (9 percent), and others (14 percent) consisting of fisheries, food, socioeconomic studies, and agricultural inputs. In crop research, cereal grains accounted for about 80 percent of research expenditure. Thus, research activities were largely limited to foodgrains, particularly rice, wheat, and maize. The 1970s also witnessed relatively greater research emphasis on hill agriculture. Factor-oriented research was almost negligible except in the use of chemical fertilizer. Input research accounted for 2 percent of the estimated actual research expenditure.

Presently, agricultural research is carried out by four departments in the Ministry of Agriculture and by other institutions outside the ministry. Even in the Department of Agriculture, the technical sections and commodity research programs are not unified. The unification of all agricultural research activities would allow a single body to effectively plan, organize, manage, control, and evaluate agricultural research activities throughout the country.

The eight commodity research programs (rice, wheat, maize, potato, citrus, sugarcane, pulses, and oilseeds) are concerned with solving a specific problem or developing a high-yielding variety without considering differences in the cropping patterns, resource endowments, or socioeconomic levels of farmers. Therefore, separate cropping system or farming system research is initiated to test the suitability of such agricultural technology in the existing farming system, but this is not a satisfactory solution. If researchers in the commodity research programs were fully cognizant of the farming systems, they could develop technologies to fit farmers' requirements. At present, an intermediary agency or unit called the Farming System Research Division tests these technologies under actual farm conditions and commonly reports to the commodity research programs that their technologies are inadequate to meet farmers' needs.

Researchers cite low salary, absence of job descriptions, low accountability, and poor training, guidance, supervision, and evaluation as causes of low motivation. Their productivity is affected by lack of proper research plans and programs, inadequate financial and administrative authority, lack of facilities for publication of research results, poor libraries, temporary appointments, and long delays in promotion. Improved management could provide the clear focus and direction that are needed to develop a strong and effective research system.

The project support approach of donors has not strengthened the overall agricultural research system in Nepal, though it has undoubtedly contributed to training researchers and building physical infrastructure in some components of agricultural research. This approach has distorted priorities and given rise to conflict between project and nonproject research staff because of differences in opportunities and privileges provided through the projects. To avoid these problems, a comprehensive plan of agricultural research is required. Donors invited to support such a plan could aid in strengthening and balancing the development of research. Currently, 32 foreign-aided projects supported by 13 different donors are in operation.

The research contact and collaboration of national research agencies with external research systems are extremely limited; such collaboration with neighboring countries is particularly low. Increased collaboration with the international research centers would be valuable. Since agricultural research is not given high priority and the capability of the system is low, there is little incentive to pursue collaboration. Nepal cannot afford to build and sustain a large, expensive agricultural research system and must rely greatly on technology from other national and international research systems. However, borrowing technology requires a certain minimum level of national research capability to carry out necessary adaptive research. Also, to collaborate effectively, Nepal's research capability needs to be expanded so that interaction with counterpart scientists in collaborating institutions becomes possible.

Another important consideration for strengthening agricultural research is the level of training required for agricultural researchers. The M.S. degree should be the minimum qualification for research scientists. Of the 400 researchers engaged in agricultural research in Nepal, more than half have only undergraduate training and only 14 have Ph.D. degrees. To meet the national training requirements of an M.S. degree in different fields of agriculture and animal science, the Institute of Agriculture and Animal Science at Rampur could be strengthened and developed into an agricultural university within the next 7 to 10 years. Doctoral training may have to be accomplished outside the country for quite some time. A research manpower development program is needed, with M.S. and Ph.D. training given high priority.

A high turnover of people at senior executive, planning, and policy levels indicates lack of continuity and commitment in implementing policies and plans. Simplification of budgetary procedures would be beneficial, as would delegation of financial and administrative authority to operational levels. Establishing a high national priority for research, unifying all agricultural research activities under an autonomous body, and improving the motivation of researchers through better personnel policies are the keys to a productive research system in Nepal.

2

INTRODUCTION

Nepal is a small Himalayan kingdom and one of the world's poorest nations, landlocked between China and India in an area of 147,482 square kilometers with a population of approximately 16 million. It is one of the least developed countries, with an estimated per capita GDP in 1982 of about U.S. $140.

The physical features of the country pose a serious constraint to its development. Nepal is divided into three physiographical belts: the Tarai (a plain that lies along the southern border between 75 and 300 meters above sea level), a wide band of hills (between 300 and 3,000 meters), and the northern mountains (from 3,000 to 8,500 meters). These three belts contain, respectively, 23, 42, and 35 percent of the total land area, and 44, 48, and 8 percent of the population. Approximately 16 percent of the total land area is under cultivation, 42 percent is under forest, 12 percent is permanent pastureland, 15 percent is under perpetual snow, and the remaining 15 percent is wasteland.[1] The Tarai, which accounts for about 54 percent of the country's total cultivated area, is the most fertile and is called the "granary of Nepal."

The considerable differences in climate within Nepal are due primarily to the variation in altitude. The Tarai is subtropical, the hills are temperate, and the mountains are alpine. These dramatic changes in climatic conditions occur over a north-south distance of only 240 kilometers.

Agriculture is the mainstay of the nation's economy, providing roughly 80 percent of employment and accounting for about two-thirds of total GDP and 80 percent of export earnings. If genuine economic development is to take place in Nepal, it will have to be led and supported by growth in agriculture, which will provide a base in the form of wage goods and capital for the development of other sectors.

In recent years, declining agricultural output has been the most crucial concern of policymakers and administrators. Accordingly, enhancing agricultural production, particularly food crop production, has been the central theme of a succession of annual agricultural development programs. All the agencies of the Ministry of Agriculture have been mobilized in direct support of the production effort, and three different types of programs are launched each year. The Intensive Program provides an integrated supply of inputs such as extension services, improved seeds, fertilizer, and credits to irrigated land in the Tarai. The Pocket Program furnishes a concentrated supply of inputs to potential pocket irrigation facilities in the hills[2] and the Tarai. The Normal Program offers encouragement in the use of improved seeds in partially irrigated areas or rainfed areas in the hills and the Tarai.

In addition to their regular work, senior officials from all government agriculture agencies, including the research division, are assigned responsibilities as district supervisors to supervise officials (program implementors) already working at the field level. These senior officials are required to identify problems faced during the execution of district agriculture programs and to provide solutions on the spot, if possible, or to present the problems at the national level. Thus, already inadequate research resources are diverted from the development of viable modern technology, which is essential for long-term development of agriculture, to augment the efforts of extension services and input supply management.

---

[1] Nepal, Agricultural Projects Services Center, *Perspective Land Use Plan (1985-2005)* (Kathmandu: APROSC, 1986).

[2] Unless otherwise specified, further references to "the hills" or "hill agriculture" will include both the hill and mountain areas of Nepal.

The main thrust of these efforts has been on expanding extension services, conducting training programs, and making inputs and credit available to farmers. Although these aspects are unquestionably important, their effectiveness is greatly dependent upon improved agricultural technologies developed through a productive research system.

Agricultural research has been given insufficient importance and does not have clear objectives and well-defined strategies and programs. The functions of agricultural research stations and farms are ambiguous and change frequently. These research sites also suffer from insufficient equipment, financial resources, and trained personnel.[3]

A thorough reappraisal is needed of the role that research could be playing. Recognition of research as the crucial subsector is vital to solving Nepal's problems of underdevelopment. A comprehensive study to examine resource allocation in depth, to analyze the factors inhibiting development of a viable and productive research system, and to develop a strategy for a long-term agricultural research system aimed at sustained development of the agricultural sector is long overdue. This study is designed to meet that need.

First, the appropriateness of national policies regarding the generation and adoption of improved agricultural technology is reviewed, and the performance of the agricultural sector is examined with particular emphasis on the foodgrain subsector. Second, a review is made of the resource allocation patterns to and within the agricultural sector in general, and agricultural research in particular. Financial and personnel allocation patterns for agricultural research in the varied ecological regions are studied in detail: for example, the hills versus the Tarai; enterprises such as crops, livestock, and horticulture; and factor-oriented research topics such as soil, water, land use, conservation, and inputs. The components of the expenditure budget in terms of capital, staff salaries, and operational expenses for each subsector are also examined. Third, the institutional development of agricultural research is reviewed and the present organization and management of research vis-à-vis the research environment is examined. An analysis is made of research planning, implementation, monitoring, and incentives as they influence research productivity. Fourth, a broad-based strategy for a national research system is suggested. This strategy includes consideration of research priorities, organizational structures, staff development, and institutional linkages within a long-term development perspective for the agricultural sector.

The study is based primarily on secondary data and official documents concerning trends in agricultural production and productivity (yield)[4] and resource allocation patterns from 1970/71 to 1980/81. In addition, 120 researchers were interviewed about their working conditions and recommendations for improving motivation in the research system. A brief description of the agricultural sector is provided. Agricultural policies, strategies, and performance during various five-year plans are reviewed. Trends in agricultural output, cropped area, productivity, and inputs use from 1960/61 to 1980/81 are discussed. The history of agricultural research and the present organization, planning, monitoring, and evaluation processes are highlighted. Financial and manpower resource allocations are discussed, as are research incentives and management. Some concluding observations are made regarding agricultural research strategies, priorities, and structures.

---

[3] Asian Development Bank/Nepal, *Nepal Agricultural Sector Strategy Study,* vol. 1 (Kathmandu: ADB and Nepal Government Press, 1982).

[4] These two terms (productivity and yield) are used interchangeably throughout the report to mean output per unit of land.

3

AGRICULTURAL PLAN, POLICY, AND PERFORMANCE—A REVIEW

The development of a productive and sustainable agricultural research system in Nepal requires a full understanding of the present agricultural system—its plan, policy, and performance. This chapter presents background information on landholdings, land distribution, farming practices, plan priorities, constraints, and policies. The performance of agriculture in foodgrain and cash crops from 1970/71 to 1980/81 is discussed, and factors contributing to increased production are analyzed.

Agricultural Background

Nepalese agriculture is largely characterized by a mixed farming system, heavily dependent upon monsoon rainfall. Only 14 percent of cultivated land is under irrigation. In 1981, the average size of holdings was estimated at 1.12 hectares per family of seven persons. The physiographical features of the country distinguish the hill agriculture from that of the Tarai. The per capita cultivated land is 0.12 hectare in the hills and 0.21 hectare in the Tarai. In the hills, the average farm size is only 0.85 hectare compared with 1.47 hectares in the Tarai. Terraced cultivation is practiced in the hills, where most of the cultivated land is in the upland category, largely devoid of irrigation, and with soil that is very low in plant nutrients. In the Tarai, where some of the cultivated land is under irrigation and most of it is potentially irrigable, flatland and lowland cultivation are practiced. The Tarai also has better physical and institutional infrastructures than are found in the hills.

Land distribution in Nepal is extremely skewed. Approximately 50 percent of households have holdings of less than one-half hectare, accounting for only 7 percent of the cultivated area. Conversely, 47 percent of cultivated land is covered by holdings of more than 3 hectares owned by only 9 percent of all households. Sixty-seven percent of households have holdings of less than 1 hectare, accounting for 17 percent of cultivated land.

The land distribution is even more skewed in the Tarai than in the hills. Among households owning less than one-half hectare of cultivated land, 46 percent of Tarai households own only 3 percent of all cultivated land in the Tarai, compared with 54 percent of hill households owning 12 percent of cultivated land in the hills. Among households owning more than 3 hectares of cultivated land, 14 percent of households in the Tarai own 58 percent of the Tarai land, compared with only 5 percent of households in the hills owning 34 percent of the hill land (see Table 1).

Crops

The principal foodgrain crops are paddy, maize, and wheat, which account for nearly 86 percent of the total cropped area and almost 93 percent of total cereal production. Paddy is cultivated on about 60 percent of the total cereal crop area. Maize, 60 percent of which is produced in the hills, occupies between 20 and 22 percent of the total cereal crop area. Although wheat is a relatively new crop in Nepal, it already accounts for between 16 and 18 percent of the total cereal crop area and is increasing.

Other minor cereal crops are millet, barley, and buckwheat. Trends over the last decade have shown no significant change in cultivated areas for these crops. The pulses are also important crops, both as part of the Nepalese diet and as key components of the cropping system in Nepal.

Jute, sugarcane, tobacco, oilseeds, and potato are the major nonfoodgrain crops and

Table 1—Farm size and distribution of cultivated landholdings, 1981

Region/Size of Holdings	Number of Households	Percentage of Total Households	Total Cultivated Hectares	Percentage of Total Cultivated Land	Average Cultivated Hectares per Holding
Nepal					
Less than 0.5 hectare	1,107,902	50.5	161,987	6.6	0.15
0.5–1.0 hectare	355,420	16.2	264,522	10.8	0.74
1.0–3.0 hectares	535,964	24.4	868,201	35.3	1.62
More than 3.0 hectares	194,623	8.9	1,160,628	47.3	5.96
Total	2,193,909	100.0	2,455,338	100.0	1.12
Tarai					
Less than 0.5 hectare	434,210	45.6	38,705	2.8	0.09
0.5–1.0 hectare	123,250	13.0	91,367	6.5	0.74
1.0–3.0 hectares	262,336	27.6	463,521	33.1	1.77
More than 3.0 hectares	131,312	13.8	807,833	57.6	6.15
Total	951,108	100.0	1,401,426	100.0	1.47
Hills and mountains					
Less than 0.5 hectare	673,692	54.2	123,282	11.7	0.18
0.5–1.0 hectare	232,170	18.7	173,155	16.4	0.75
1.0–3.0 hectares	273,628	22.0	404,680	38.4	1.48
More than 3.0 hectares	63,311	5.1	352,795	33.5	5.57
Total	1,242,801	100.0	1,053,912	100.0	0.85

Source: Nepal, Central Bureau of Statistics, *Sample Census of Agriculture* (Kathmandu: CBS, 1981).

account for 10 to 12 percent of the total cropped area.

Livestock

Livestock are an integral part of the farming system in Nepal. Livestock production accounts for 21 percent of the total agricultural output and 15 percent of GDP. The most important animals are buffalo, cattle, goat, sheep, yaks, and pigs. Nepal has one of the highest ratios of grazing livestock per capita (5.8 animals per household) in the world. However, the productivity is extremely low because of low genetic potential, inadequate feeding, poor management, and widespread disease.

Horticulture

The wide climatic variation provides great scope for horticultural development in Nepal. Temperate-zone fruits can be successfully grown in the mountains and hills, citrus in the hills and the Tarai, and a range of tropical fruits in the Tarai. However, because of inadequate physical infrastructure and lack of an organized marketing network, this subsector is relatively undeveloped.

Fisheries

Because Nepal is a landlocked country, only inland fishery development is practiced. There are some river and pond fisheries. This subsector is gradually getting more attention in the country, though fish production constitutes a negligible part of the total agricultural output.

Agricultural Plans and Policies

In spite of a substantial investment in the agricultural sector (which comprises agriculture, forestry, irrigation, land reform, and cadastral survey) in the five-year plans between 1956 and 1980, agricultural productivity has remained relatively stagnant or, in some commodities, has declined.

Transport and communication received the highest priority during the first four plans (1956-75). It was only from the Fifth Plan that the agricultural sector received very high priority—with an allocation of 29.80 percent (actual expenditure was 25.43 percent) of the total plan outlay (see Appendix 1, Table 37). From 1970/71 to 1980/81, the agricultural sector expenditure increased from Rs 106.6 million to Rs 336.1 million (1972/73 rupees) at an annual rate of 14 percent. In the same period, total development expenditure increased at an annual rate of about 11 percent from Rs 523 million to Rs 1,356 million (see Appendix 1, Table 38). The agricultural sector was accorded the highest priority in the Sixth Five-Year Plan (1980-85) with an allocation of 30.34 percent of the total plan outlay to achieve a target annual growth rate of 3.2 percent (Appendix 1, Table 37).

Agricultural development strategy based on geographical comparative advantages was identified and initiated in the Fifth Plan. Accordingly, the plan emphasized foodgrain production in the Tarai, horticulture production in the hills, and livestock production in the mountains.

The Ten-Year Agriculture Plan (1975-85), prepared at the Investigation and Enquiry Centre of the Palace, had outlined four comprehensive objectives: to increase agricultural production and productivity on a sustained basis, both quantitatively and qualitatively, in view of rising population; to produce agricultural commodities needed to develop and sustain industry and trade and to support trade promotion and diversification; to pursue regional specialization in agricultural production based on geographical comparative advantages, needs, and priorities; and to improve the standard of living of farm families through agricultural development and creation of more employment opportunities for agricultural labor in the farm sector. Although the ten-year plan had carefully outlined the relevant objectives, strategies, and policies for agricultural development in Nepal, only the recommended organizational structure was effected; otherwise, the plan document remained mostly on the shelf.

Development Constraints

Past experience in agricultural development throughout various plans has emphasized the following constraints:

- Lack of suitable varieties of improved seeds for agricultural crops grown in different climatic regions of the country.
- Poor transport and communication along with rudimentary marketing networks; inadequate irrigation facilities, making agriculture largely dependent on the vagaries of the monsoon.
- Inadequate production support services such as improved seeds, fertilizers, insecticides, credit, and extension.
- Inadequate production incentives to farmers due to inequitable land tenure systems and an unfavorable price regime of agricultural inputs and output; insufficient motivation for researchers and extension workers to perform their work effectively.
- Lack of coordination and consistency in policy formulation, planning, and implementation for the use of land, water, and forests.
- Indiscriminate deforestation and lack of soil conservation measures leading to ecological imbalance and decline in soil fertility.

Recommended Policies

The following policies were recommended for agricultural development in the various plans:

- Generation of appropriate technologies suitable to different soil and climatic conditions; promotion of labor-intensive agricultural technology to create employment.
- Development of irrigation facilities to reduce dependency of agriculture on the vagaries of the monsoon and to raise agricultural production and productivity through intensification and multiple cropping.
- Program coordination of forestry, agriculture, and irrigation, with emphasis on scientific land use and improved conservation practices; integration and improvement in delivery of inputs, credits, and other services of various government agencies.
- Provision of incentives to increase production by instituting a favorable

price policy of agricultural inputs and outputs and implementing land reform programs to benefit the actual tillers of the land.

- Improvement in the income levels of small farmers, tenants, and landless agricultural laborers through special agricultural development projects such as the Small Farmer Development Project.
- Government directives to the commercial banks to lend a minimum of 7 percent of their total deposits to the agricultural and small-scale industry sectors.

Agricultural Performance

In the last two decades, agricultural productivity has declined in Nepal. During the same period, the cropped area has increased.

Trends in Agricultural Production and Productivity

From 1961/62 to 1980/81, total cereal grain production increased by an annual rate of only 1.10 percent, while productivity (yield) declined by 0.58 percent annually. The cropped area during this period increased by 1.69 percent annually. The annual rates of growth of foodgrain crops are presented in Table 2.

In the 1970s, total cereal grain production increased at an annual rate of 0.95 percent compared with 0.75 percent in the 1960s. Productivity declined at 0.46 percent annually in the 1970s compared with a decline of 1.0 percent in the 1960s. Similarly, the cropped area in the second period increased at 1.42 percent compared with 1.77 percent in the first period. Thus, both declines in productivity and increases in cropped area were smaller in the 1970s than in the 1960s.

Table 2—Annual growth rate of cereal crop area, production, and yield, 1961/62-1980/81

Cereal Crop/ Growth Segment	1961/62-1969/70		1970/71-1980/81[a]		1961/62-1980/81[a]	
	Percent	t-Statistic	Percent	t-Statistic	Percent	t-Statistic
Paddy						
Area	0.97	5.82	0.93	4.10	0.99	13.18
Production	0.45	1.02	0.73	1.03	0.90	4.16
Yield	−0.49	−1.25	−0.20	−0.39	−0.09	−0.51
Maize						
Area	−0.21	−0.56	0.24	1.81	0.24	2.24
Production	−1.36	−2.84	−1.06	−2.62	−0.66	−4.03
Yield	−1.15	−5.17	−1.30	−3.68	−0.90	−8.26
Wheat						
Area	10.31	4.49	5.82	10.16	8.34	15.33
Production	9.41	5.38	8.64	7.54	8.00	16.09
Yield	−0.84	−1.17	2.67	2.74	−0.33	−0.78
Barley						
Area	1.27	2.43	−0.71	−2.35	0.48	2.81
Production	−0.23	−0.22	−1.19	−1.83	−0.55	−1.83
Yield	−1.52	−2.08	−0.49	−1.26	−1.02	−4.30
Millet						
Area	7.61	6.01	0.54	1.78	3.48	7.05
Production	11.40	4.82	−0.44	−0.81	4.18	4.96
Yield	3.60	3.28	−0.97	−3.32	0.68	1.87
Total cereals						
Area	1.77	7.82	1.42	8.13	1.69	23.46
Production	0.75	2.21	0.95	2.10	1.10	7.60
Yield	−1.00	−2.82	−0.46	−1.39	−0.58	−4.74

Source: Unpublished data on area, production, and yield from the Department of Food and Agricultural Marketing Services, Nepal.

[a] 1979/80 is omitted because it was a drought year.

The productivity of wheat showed a positive growth rate of 2.67 percent in the 1970s. The productivity of maize, paddy, barley, and millet registered a negative growth rate. Maize, the second most important cereal grain, declined in both production and productivity at annual rates of 1.06 and 1.30 percent, respectively.

The per capita net (edible) foodgrain production declined from 185 kilograms in 1970/71 to 160 kilograms in 1980/81 (see Table 3). During this period, the real GDP grew at an annual rate of 1.53 percent, while the population increased at an annual rate of approximately 2.70 percent. Therefore, the real per capita income declined. The slow growth of GDP is essentially due to stagnation in agricultural production. The real agricultural GDP did not show any trend upward and remained almost stagnant for the whole period (Appendix 1, Table 38).

Production and yield in the hills and mountains declined much faster than in the Tarai from 1970/71 to 1980/81 (see Table 4). In the Tarai, total cereal grain production increased annually by 1.44 percent and yield remained almost unchanged. During the same period, production in the hills remained constant and yield declined annually at 1.14 percent. An increase in the cropped area for the Tarai, at the rate of 1.50 percent annually, kept production rising without any change in yield, while a decline in yield for the hills was offset by a 1.27 percent increase in the cropped area that left total production undiminished.

Wheat area, production, and yield increased faster in the Tarai than in the hills. The production of wheat in the Tarai increased substantially at 12.79 percent annually because of annual increases in yield of 3.96 percent and in cropped area of 8.50

Table 3—Per capita food production, 1970/71-1980/81

Year	Population	Food Production (Gross)	Food Production (Net)	Per Capita Net Foodgrain Production
	(millions)	(1,000 metric tons)		(kilograms)
1970/71	11.56	3,486	2,183	185
1971/72	11.87	3,492	2,170	183
1972/73	12.18	3,303	2,137	175
1973/74	12.50	3,706	2,330	186
1974/75	12.83	3,781	2,410	188
1975/76	13.17	3,908	2,436	185
1976/77	13.52	3,704	2,332	172
1977/78	13.88	3,585	2,262	163
1978/79	14.25	3,653	2,302	162
1979/80	14.63	3,196	2,000	137
1980/81	15.02	3,829	2,409	160

Source: Unpublished data on gross and net food production from the Department of Food and Agricultural Marketing Services, Nepal.

Notes: Population for various years is calculated on the basis of annual rate of growth of 2.66 percent. Conversion of gross food production into net (edible) food is made by the DFAMS as follows:

Losses in storage	10 percent
Losses in milling, for rice	40 percent
Losses in milling, for other grains	3 percent
Retention for seeds	
Paddy	55 kilograms per hectare
Maize	20 kilograms per hectare
Wheat	100 kilograms per hectare
Millet	20 kilograms per hectare
Barley	40 kilograms per hectare
Other losses	1 – 1.5 percent

Table 4—Annual growth rate of cereal crop area, production, and yield, by region, 1970/71-1980/81

Cereal Crop/ Growth Segment	Hills		Tarai		Total Nepal	
	Percent	t-Statistic	Percent	t-Statistic	Percent	t-Statistic
Paddy						
Area	1.98	8.93	0.71	2.96	0.93	4.10
Production	0.72	1.45	0.73	0.87	0.73	1.03
Yield	−1.24	−3.25	0.01	0.02	−0.20	−0.39
Maize						
Area	0.72	4.94	−0.86	−3.99	0.24	1.81
Production	−1.14	−2.30	−0.88	−1.11	−1.06	−2.62
Yield	−1.84	−4.70	−0.02	−0.02	−1.30	−3.68
Wheat						
Area	2.08	3.41	8.50	6.60	5.82	10.18
Production	3.86	6.05	12.79	5.17	8.64	7.54
Yield	1.74	3.51	3.96	2.13	2.67	2.74
Barley						
Area	0.24	1.00	−3.35	−1.89	−0.71	−2.35
Production	−1.61	−3.48	−0.20	−0.08	−1.19	−1.83
Yield	−1.85	−4.16	3.25	2.61	−0.49	−1.26
Millet						
Area	0.69	2.07	−0.24	−0.56	0.54	1.78
Production	−0.54	−0.86	0.16	0.31	−0.44	−0.81
Yield	−1.22	−3.54	0.41	2.41	−0.97	−3.32
Total cereals						
Area	1.27	8.77	1.50	5.90	1.42	8.13
Production	0.12	0.38	1.44	2.30	0.95	2.10
Yield	−1.14	−3.87	−0.06	−0.12	−0.46	−1.39

Source: Computed from unpublished data on area, production, and yield from the Department of Food and Agricultural Marketing Services, Nepal.
Note: 1979/80 is omitted because it was a drought year.

percent. Wheat production in the hills, however, increased at a rate of only 3.86 percent, with a productivity growth of 1.74 percent and cropped area growth at 2.08 percent.

The annual growth rates in area, production, and yield of cash crops are shown in Table 5. The area under cash crops increased at an annual rate of 2.23 percent from 1961/62 to 1980/81. From 1970/71 to 1980/81 the cash crop area increased by 1.12 percent compared with 3.19 percent from 1961/62 to 1969/70. Area and production of all cash crops, except tobacco, increased from 1961/62 to 1980/81. Sugarcane had the highest growth rate, 8.86 percent, while jute production increased only 2.46 percent. The yield of sugarcane and oilseeds increased, that of tobacco and potatoes declined, and jute yield remained almost constant. From 1970/71 to 1980/81, the area, production, and yield increased for sugarcane and oilseeds but declined for tobacco and potatoes. In the 1960s, area and production of all cash crops except oilseeds increased, while the yield of jute, tobacco, and potatoes declined. In general, the growth in yield of cash crops was better than for cereal crops, but was not highly encouraging.

Wheat and sugarcane showed an increase in production and productivity between 1961/62 and 1980/81. The data on the use of fertilizer for crops are not available on a yearly basis, so it is difficult to show empirically the effect of fertilizer use on the productivity increase of wheat and sugarcane. However, in 1981/82, chemical fertilizer was used on 17 percent of total area under wheat and 12 percent of total area under sugarcane, compared with only 3 and 8 percent of total area under maize

Table 5—Annual growth rate of cash crop area, production, and yield, 1961/62-1980/81

Cash Crop/ Growth Segment	1961/62-1969/70		1970/71-1980/81		1961/62-1980/81	
	Percent	t-Statistic	Percent	t-Statistic	Percent	t-Statistic
Sugarcane						
Area	11.72	5.10	6.12	6.18	7.43	12.50
Production	13.94	6.96	7.41	6.58	8.86	13.76
Yield	1.99	3.10	1.22	2.33	1.33	6.66
Jute						
Area	7.00	4.54	−1.18	−0.52	2.07	2.42
Production	3.60	4.77	1.38	0.75	2.46	4.54
Yield	−3.18	3.24	2.60	2.51	0.38	0.76
Oilseed						
Area	−1.67	2.83	2.06	2.61	1.10	3.20
Production	0.75	1.58	4.40	4.60	2.62	7.41
Yield	2.46	4.91	2.29	6.15	1.51	8.26
Tobacco						
Area	9.75	5.32	−1.51	−0.79	1.26	1.34
Production	3.20	0.88	−3.03	−1.70	−1.11	−1.17
Yield	−5.97	−2.82	−1.54	−2.88	−2.34	−4.14
Potato						
Area	12.42	6.96	−0.02	−0.05	4.74	2.77
Production	10.07	4.31	−0.74	−1.18	3.31	4.12
Yield	−2.09	−2.06	−0.73	−1.93	−1.37	−6.15
Total cash crops						
Area	3.19	12.48	1.12	1.60	2.23	9.41

Source: Computed from unpublished data on area, production, and yield from the Department of Food and Agricultural Marketing Services, Nepal.
Note: 1979/80 is omitted because it was a drought year.

and paddy, respectively.[5] Similarly, the national average use of fertilizer per hectare was 14 kilograms on wheat and 29 kilograms on sugarcane, compared with only 3 kilograms on maize and 4.5 kilograms on paddy. It is commonly observed that wheat and sugarcane are grown where some irrigation facilities are available, unlike paddy and maize, which are largely grown under rainfed conditions.

Decomposition of Growth Trends

Table 6 presents the annual growth rates (compound) of agricultural production and its components from 1961/62 to 1980/81. (See Appendix 2 for methodology.) This period was divided into two parts, 1961/62-1969/70 and 1970/71-1980/81, because of the possible effect of the "green revolution" in the 1970s. The growth rates of agricultural production and its components for the two periods, and for the combined period, clearly indicate that area effect is the dominating factor in the growth of agricultural production. The yield effect on production in these periods was negative.

From 1961/62 to 1969/70, negative yield effect was much greater than during 1970/71-1980/81. Moreover, the value in the second period was not significantly different from zero. Thus one may argue that the decline in production due to negative yield effect has been arrested, perhaps owing in part to improved technology. On the other hand, the cropping pattern effect was positive in the first period but negative in the second period. The positive sign of the cropping pattern implies a shift in favor of high-value crops. The first period showed

---

[5] Nepal, National Planning Commission, Central Bureau of Statistics, *National Sample Census of Agriculture 1981/82* (Kathmandu: CBS, 1985).

Table 6—Annual growth rates (compound) of agricultural production and its components, 1961/62-1980/81

Period	Total Value of Production	Area Effect	Yield Effect	Cropping Pattern Effect	Interaction Between Yield and Cropping Effects
			(percent)		
1961/62-1969/70	1.522	1.901	−0.637	0.296	−0.038
1970/71-1980/81	1.125	1.441	−0.270[a]	−0.214	0.168
1961/62-1980/81	1.406	1.702	−0.304	−0.004[a]	0.012

Source: Unpublished data on area, production, and yield from the Department of Food and Agricultural Marketing Services, Nepal.

[a] Not significant at 95 percent level of confidence.

an increase in the proportion of cropped area under high-value crops such as sugarcane and tobacco. In the second period, there were substantial increases in the cropped area under wheat, which is a low-value crop compared with cash crops.

This analysis indicates that the application of improved technology has begun to influence the total production by arresting further decline in productivity. However, the direct positive contribution of technology to production has yet to occur. The exception is in the case of wheat, where there was a positive growth rate in productivity. The increase in production was mostly due to increases in cropped area, rather than increases in productivity, in contrast with the improvements in productivity that contributed to more than 70 percent of the food production growth in developing countries between 1961 and 1980.[6]

Trends in Use of Inputs

The use of fertilizer between 1970/71 and 1980/81 increased threefold, from 18,000 to 54,000 tons annually.[7] Despite this rapid increase, the overall rate of fertilizer application in 1980/81 was only 9 kilograms per cropped hectare, which is among the lowest in the world.[8] Also, the application of fertilizer was very uneven on a geographical basis. The most intensive fertilizer use occurred in the Kathmandu Valley (Kathmandu, Bhaktapur, and Lalitpur hill districts), accounting for more than one-third of total fertilizer use in the country. Less than one-fifth of total fertilizer use was in the remaining 52 hill and mountain districts (see Table 7). The average fertilizer use rate in Kathmandu Valley was about 72 kilograms per hectare per year, while in the Tarai and the hills (excluding the Kathmandu Valley), fertilizer rates were only about 9 kilograms and 4 kilograms of nutrients per hectare, respectively.[9]

The disbursement of institutional credit from the Agricultural Development Bank increased sevenfold from Rs 19 million to Rs 134 million between 1970/71 and 1980/81. Only 24 percent of the borrowing farm families borrowed from institutional sources in 1976/77; the rest had to depend upon private sources. Of the total amount borrowed, only 42 percent came from institutional sources.[10]

---

[6] Leonardo A. Paulino, *Food in the Third World: Past Trends and Projections to 2000,* Research Report 52 (Washington, D.C.: International Food Policy Research Institute, 1986).

[7] All tons referred to in this report are metric tons.

[8] John M. Hill, *A Fertilizer Strategy for Nepal* (Muscle Shoals, Ala.: International Fertilizer Development Center, 1982), p. 25.

[9] Ibid., p. 27.

[10] Nepal Rastra Bank, *Agricultural Credit Review Survey* (Kathmandu: Nepal Rastra Bank, 1980).

Table 7—Annual consumption of chemical fertilizer, 1970/71-1980/81

Year	Hills	Kathmandu Valley	Tarai	Nepal
		(metric tons)		
1970/71	281	10,465	6,982	17,728
1971/72	1,145	12,368	11,921	25,434
1972/73	1,718	16,564	13,767	32,049
1973/74	2,051	15,474	19,252	36,777
1974/75	2,166	13,076	21,151	36,393
1975/76	3,340	12,039	15,750	31,129
1976/77	4,590	14,421	18,833	37,844
1977/78	6,726	15,753	22,754	45,233
1978/79	7,655	15,862	22,073	45,590
1979/80	9,593	16,503	24,191	50,287
1980/81	9,997	18,093	25,910	54,000

Source: Unpublished data from the Agriculture Inputs Corporation, Nepal.

The area under improved seeds of cereal crops, mainly wheat, paddy, and maize, increased substantially from 1970/71 to 1980/81. The area under improved wheat increased from 98,200 hectares in 1970/71 to about 380,000 hectares in 1980/81, achieving almost total saturation of wheat area under improved seed. Improved wheat varieties were introduced in Nepal only in 1960. The areas under improved paddy seed increased from 68,000 hectares in 1970/71 to 322,000 hectares in 1980/81, increasing the proportion of area under improved seed from 6 percent to 25 percent. Similarly, the area under improved maize increased from 12,000 hectares in 1970/71 to 157,000 hectares in 1980/81, raising the proportion of area under improved seed from 3 percent to 34 percent (see Table 8).

Annual data on irrigation are not collected systematically. The estimated total command area under irrigation in the country by 1980/81 was about 500,000 hectares, of which year-round irrigation facilities were available to only 115,000 hectares, which is only 4 percent of total cultivated land.[11]

District Agriculture Development offices have been opened in all 75 districts of Nepal to carry out extension services. The Training and Visit Extension System advocated by the World Bank has also been introduced in all 20 Tarai districts.

Research System Outputs

The agricultural research system released a total of 29 rice varieties between 1960 and 1985 (see Appendix 1, Table 39). Of these 29 varieties, 10 were intended for hills and 5 for rainfed conditions (Tarai only). Popular rice varieties among farmers were CH-45, Khumal-3, Taichung Native-1, Masuli, Sabitri, Janaki, Kanchan, Himali, and Bindeswari. Almost all varieties require irrigated land and high fertilization rates to perform well in the farmers' fields. An exception is Masuli, which can perform well even under medium to low levels of fertilization. No improved variety was available for upland rainfed rice cultivation during this period.[12]

Ten maize varieties were released between 1959 and 1985. Of these, three were for the Tarai, three for the hills, and four for both ecological areas. All varieties require medium to high fertilization levels and are recommended for both irrigated and rainfed conditions. Khumal yellow, Rampur composite, Arun-2, and Makalu-2 were the most popular varieties among farmers.

Fifteen wheat varieties have been released to date. Of these, 3 were for the hills, 11 for the Tarai, and 1 for both regions. All varieties are recommended for both irrigated and rainfed conditions and medium to high fertilizer use. Among these varieties, only Lerma-52, RR-21, and UP-262 were popular among farmers. Almost 80 percent of the improved wheat crop is RR-21. Lerma-52 was probably the next most popular variety but was used almost exclusively in the hills.

The progress in agricultural production does not seem commensurate with the

---

[11] Asian Development Bank/Nepal, *Nepal Agricultural Sector Strategy Study*, vol. 2 (Kathmandu: ADB, 1982), p. 77.

[12] Nepal, Department of Agriculture, *The Integration of Research and Extension in Farmers' Fields: The Terminal Report of the Integrated Cereals Project* (Kathmandu: Ministry of Agriculture, 1985), pp. 49-51.

Table 8—Area under high-yielding varieties (HYVs) of wheat, paddy, and maize, 1970/71-1980/81

	Wheat			Paddy			Maize		
Year	Total Area	High-Yielding Varieties Area	Percentage of HYV Area	Total Area	High-Yielding Varieties Area	Percentage of HYV Area	Total Area	High-Yielding Varieties Area	Percentage of HYV Area
	(1,000 hectares)			(1,000 hectares)			(1,000 hectares)		
1970/71	228	98.2	43.1	1,182	67.8	5.7	446	11.6	2.6
1971/72	239	115.9	48.5	1,201	81.6	6.8	434	20.8	4.8
1972/73	259	170.3	65.7	1,139	177.3	15.5	437	35.1	8.0
1973/74	275	206.8	75.2	1,226	205.1	16.7	453	74.1	16.5
1974/75	291	246.9	84.8	1,240	222.6	18.0	458	79.0	17.2
1975/76	329	233.5	71.0	1,256	216.4	17.2	450	66.3	14.7
1976/77	348	254.2	73.0	1,262	220.3	17.4	445	83.0	18.6
1977/78	366	265.2	72.4	1,264	290.5	23.0	454	98.7	21.7
1978/79	374	311.3	83.2	1,263	326.8	25.8	432	108.8	25.2
1979/80	367	367.0	100.0	1,254	323.9	25.8	457	121.3	26.5
1980/81	391	380.0	97.0	1,276	322.2	25.2	457	157.1	34.4

Sources: Dana G. Dalrymple, *Development and Spread of High-Yielding Varieties of Wheat and Rice in the Less-Developed Nations*, Foreign Agricultural Report No. 95 (Washington, D.C.: U.S. Department of Agriculture, September 1978); and unpublished data from the Department of Agriculture, Nepal.

achievement in application of improved agricultural inputs. Although increases in the use of agricultural inputs are large in percentage terms, they are so small in absolute terms that their impact may not be measurable, particularly if the output measures themselves are relatively weak. Also, poor quality of improved seed, lack of irrigation, and inadequate use of fertilizer may be the reasons for the low yields.

Four hill districts (Kathmandu, Bhaktapur, Lalitpur, and Kabhre) and seven Tarai districts (Morang, Dhanusha, Bara, Parsa, Chitawan, Rupandehi, and Kapilbastu) contain about one-fourth of the total cropped area (2.4 million hectares) of the country. The Agriculture Inputs Corporation indicates that about 70 percent of the total fertilizer sale occurred in these 11 of the 75 districts in Nepal. Conversely, only 30 percent (about 15,000 tons of chemical fertilizer) was used on the three-fourths of total cropped area in the remaining 64 districts.[13] Thus the overall impact of fertilizer on agricultural productivity has not been noticeable at the national level. Even though there has been significant increase in the use of improved varieties, their performance in the field has not been satisfactory because of the absence or inadequate use of fertilizer and the lack of irrigation.

Frequent examples have been found of winter wheat grown as a second crop after paddy without large applications of fertilizer, resulting not only in very poor yields but also in substantially reduced yields of the paddy that followed. The decline in fertility arises from the compounding of two factors. One is loss of soil nutrients as the crop nutrient balance is upset by increased cropping intensity. The other is physical degradation, particularly in terms of moisture and air retention. A crop-nutrient balance study carried out at several cropping system sites indicates that less than half of all nutrients removed from the soil by crops in one year are being replaced by the application of organic and inorganic fertilizers.[14]

---

[13] Nepal, Agriculture Inputs Corporation, *Basic Statistics of Agricultural Inputs in Nepal* (Kathmandu: AIC, 1983).

[14] S. B. Matherma, et al., "Notes on the Economics of the Use of Inorganic Fertilizer in Nepal," paper presented at the Eighth Summer Crops Workshop at Rampur, January 1981.

The five-year plans seem to have correctly identified the major constraints, outlined clear objectives, and recommended appropriate broad policy measures for the development of agriculture. However, the achievements have been disappointing, implying a lack of serious commitment to putting these policies into effect. The plans have mentioned institutional reform to motivate farmers to take advantage of improved agricultural technology, but no significant reforms seem to have been effected from 1960 to 1985 except, for a few years, the state monopoly of rice marketing, which was aimed primarily at increasing the revenue earnings rather than providing remunerative prices to the farmers. The difficulty of translating these policies into action has been compounded by adverse sociopolitical environments.

4

INSTITUTIONAL DEVELOPMENT OF AGRICULTURAL RESEARCH

Historically, agricultural research in Nepal has received low priority, since the presumption has always been that technology can be easily borrowed from outside. Researchers have been largely preoccupied with providing support services to development activities rather than concentrating on research work.

In the process of institutional development, the organization of agricultural research has evolved through three stages. First, there was a focus on a multidisciplinary approach, with research, extension, and training integrated under the Department of Agriculture. In the second stage, the Department of Agriculture was divided into five separate departments and agricultural research in the country became disintegrated and uncoordinated, since each department carried out its research and development work independently. The concept of multidisciplinary stations at the field level was abandoned during this period. The lack of coordination among the five departments emerged as a key factor for their amalgamation into one department in the third stage. Again, all agricultural research and extension activities were brought under one Department of Agriculture. All research units were made responsible for providing support services to extension, thus undermining their research capabilities. Changes in responsibilities among the deputy directors general of the department led to further disintegration of the research structure. The later creation of a separate Department of Livestock and Animal Health exacerbated this disintegration.

The Research Coordination Committee of the Ministry of Agriculture, which is at the apex of the system, has not been effective in fulfilling its planning and coordination role in agricultural research. Inadequate foreign assistance has contributed little to the development of a viable national agricultural research system, partly because of a project approach to funding. The weak research system has derived few of the benefits potentially available through greater and more active collaboration with other national and international agricultural research systems.

The beginning of agricultural research activities in Nepal can be traced back to 1924 with the opening of the Department of Agriculture and the establishment of a trial-demonstration farm in Singh Durbar, Kathmandu, and a fruit nursery farm at Godavary, Lalitpur. Agricultural farms were established later at Janakpur, Pokhara, and Parwanipur.

Starting in 1955, research sections, agricultural stations, and farms were established to test and modify technologies that were borrowed from neighboring and other foreign countries. In 1957 the Department of Agriculture, within the Ministry of Agriculture, consisted of a central directorate office with a director and two assistant directors and the following sections: Agronomy, Horticulture, Livestock and Dairy, Veterinary, Agricultural Engineering, Plant Pathology, Entomology, and Fisheries. The Department of Agriculture was responsible for overall development of agriculture in the country and carried out the three primary functions of research, training, and extension. The sections mentioned above were primarily responsible for research but also provided support services to extension programs through training and subject matter specialists.

The First Five-Year Plan (1956-60) put the primary focus on adaptive research for cereal crops—mainly paddy and maize—and finger millets.[15] Japanese varieties of paddy had shown considerable success in yields over local varieties. Similarly, Armillo de Cubano Flint—a variety of maize obtained from the United States—had demonstrated an increase in yield of 30 to 50 percent over local varieties on farmers' fields in the Tarai and submountain regions. Five new sections were opened in the Department of Agriculture during the First Plan: School of Agriculture, Agricultural Marketing and Farm Management (agricultural economics), Agricultural Extension, Soil, and Agricultural Botany.

---

[15] Nepal, Ministry of Agriculture, *A General Outline of the First Five-Year Plan for Agriculture Development* (Kathmandu: MOA, 1957).

During this period, the formation of a Council of Agriculture was proposed. This group was to act as an advisory body to the Department of Agriculture in all matters of departmental activities, namely, research, extension, and teaching, but the council was never established.

In the 1960s, both the government and foreign donors believed that Nepal could benefit from technologies that brought the green revolution to many developing countries by dissemination of these technologies to farmers and provision of support services to accelerate their adoption. With land reform providing the farmers more incentives to produce, and with the establishment of village cooperative societies to supply the necessary inputs and credits, Nepal appeared to be ready for "takeoff" with an extension program that would have a real effect on production.[16]

In 1965/66 an intensive, coordinated agricultural development program was initiated with the assistance of the U.S. Agency for International Development (USAID) in 9 of Nepal's most productive districts—6 in the Tarai and 3 in Kathmandu Valley. This program was expanded to another 7 districts in the Tarai in the following year, and an intensive production program was established in 16 districts with improved practices accompanied by production inputs.

An integration of research and extension is reflected in the proposed regional program of the Department of Agriculture in 1966. The field activities of agricultural development were grouped into six regions. All the subject matter specialists on agricultural stations or farms in each region and all extension personnel were collectively responsible for agricultural development in those regions. Their job descriptions and responsibilities were clearly defined. This program emphasized extension activities more than research activities, perhaps because of a political thrust to show the effect on agricultural production of the land-reform program initiated in 1964 and the presumption that varieties and practices developed elsewhere could easily be transferred to farmers' fields.

As this regional program was about to be carried out in 1966, the Department of Agriculture was dissolved and five new departments were created in the Ministry of Agriculture: Agricultural Education and Research, Agricultural Extension, Horticulture, Livestock and Veterinary Science, and Fisheries.

The Agricultural Economics Section of the former Department of Agriculture was renamed the Economic Analysis and Planning Division (EAPD) and was brought directly under the Ministry of Agriculture. Its role was to conduct socioeconomic and marketing research. In addition, it was responsible for the overall planning and evaluation of agricultural programs in the Ministry of Agriculture.

Under the new organizational arrangements, the Department of Agricultural Education and Research consisted of seven sections, five agricultural stations, and five agricultural farms. The College of Agriculture was established under this department to conduct undergraduate training in agriculture and animal husbandry.

The Department of Agricultural Extension had two sections, namely, the Agricultural Information Section and the Rural Youth (4-H) Program Section. Extension activities throughout the country were organized and supervised by this department.

---

[16] U.S. Agency for International Development, *Project History and Analysis Report—Agricultural Extension and Training* (367-11-110-054) (Washington, D.C.: USAID, 1965).

The Department of Livestock and Veterinary Science, responsible for animal research and development, consisted of 3 sections, 4 livestock development stations, 3 sheep development centers, 7 artificial insemination service centers, 4 poultry projects, and 33 veterinary hospitals. The Department of Horticulture had 18 horticultural farms and the Department of Fisheries had 7 fishery centers.

Before the reorganization of the Department of Agriculture, the agricultural stations were organized on a multidisciplinary basis. Field crops, horticulture, and livestock research were integrated at each station and the station manager was the coordinator of all activities. After the reorganization, the concept of the unified multidisciplinary station was abandoned. Each department wanted to have a portion of each station under its control. This led to fragmentation of the stations, without overall coordination, since each station section was directly responsible to its respective department. This fragmentation also duplicated logistical tasks, since each section had its own administrative unit, and complicated and lengthened the coordination process.

In the formulation and implementation of programs, there was a serious lack of coordination among departments within the same ministry. Because of these coordination problems and sluggish growth in agricultural production, three top-level agricultural technicians were asked by Janch Bujha Kendra (the Investigation and Enquiry Centre of the Palace) to prepare a 10-year agriculture plan and to suggest an effective organizational setup. The 10-year agricultural development program was approved by the government, and the organizational setup, as outlined in the plan, was established in 1972/73. The five departments that had been created in 1966 were amalgamated into one Department of Agriculture. The organizational structure of the department is shown in Figure 1.

The new element in the proposed structure of the department was regionalization (to match the regional corridor development concept of the government).[17] Regional agricultural directorates were opened in four development regions of the country (Eastern, Central, Western, and Far Western)[18] to carry out agricultural development activities, with the main focus on extension services.

The crop-coordinated research program that had been initiated in 1971, under the Department of Agricultural Education and Research, received due recognition. Coordinated crop development programs were launched for paddy, wheat, maize, citrus, and potatoes, emphasizing agricultural improvement through problem-oriented, multidisciplinary research teams concentrating their attention on a major commodity or problem area.

Horticulture was divided into two separate sections, Fruit Development and Vegetable Development. Similarly, livestock was divided into Animal Development Section 1 and Animal Development Section 2. Section 1 was responsible for the development of large animals such as buffalo, cattle, and yaks, and for feed fodder and pasture. Section 2 was responsible for the development of small animals and birds such as sheep, goats, pigs, and poultry.

Thus agricultural research was organized into sections, partly on a commodity basis and partly along discipline lines. Each section was entrusted with the responsibilities of both research and development. This led to gradual dilution of research efforts in favor of extension activities. Research units were placed in two categories, based on their coverage of either national (central) or regional agricultural research and development programs.

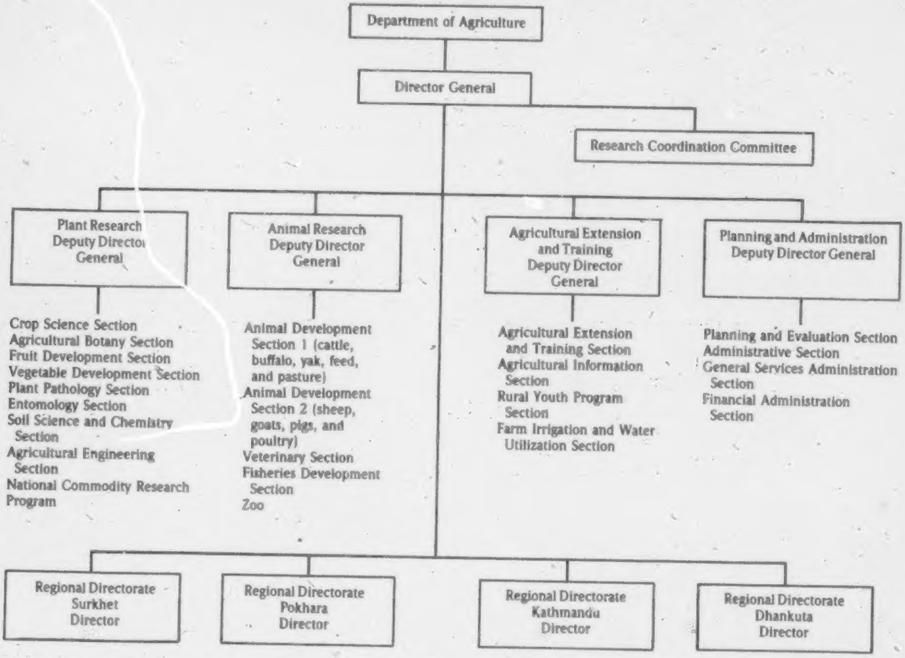
The sections and agricultural stations that engaged in research to support the national agricultural development activities fell into

---

[17] In the Fourth Five-Year Plan (1970-75), considering national development in spatial dimension, growth axes were proposed along major north-south roads. This led to creation of four development regions in 1972. For detailed discussion on regional development strategy see Nepal, National Planning Commission, *The Fourth Plan, 1970-75* (Kathmandu: NPC, 1970), Appendix 3, pp. 328-340.

[18] In 1980 the Far Western Region was split into two regions (Midwestern and Far Western), creating the present total of five regional agricultural directorates.

Figure 1—Organization chart of the Department of Agriculture, 1972/73


Department of Agriculture
Director General
Research Coordination Committee
Plant Research Deputy Director General
Animal Research Deputy Director General
Agricultural Extension and Training Deputy Director General
Planning and Administration Deputy Director General
Crop Science Section
Agricultural Botany Section
Fruit Development Section
Vegetable Development Section
Plant Pathology Section
Entomology Section
Soil Science and Chemistry Section
Agricultural Engineering Section
National Commodity Research Program
Animal Development Section 1 (cattle, buffalo, yak, feed, and pasture)
Animal Development Section 2 (sheep, goats, pigs, and poultry)
Veterinary Section
Fisheries Development Section
Zoo
Agricultural Extension and Training Section
Agricultural Information Section
Rural Youth Program Section
Farm Irrigation and Water Utilization Section
Planning and Evaluation Section
Administrative Section
General Services Administration Section
Financial Administration Section
Regional Directorate Surkhet Director
Regional Directorate Pokhara Director
Regional Directorate Kathmandu Director
Regional Directorate Dhankuta Director

Source: Nepal, Ministry of Agriculture, *Ten-Year Agriculture Plan* (Kathmandu: MOA, 1972).

the first category, the Central Research Program. All the plant and animal science research sections, national coordinated crop development programs, and agricultural research stations were administered by the Central Directorate of Agriculture in Kathmandu.

Research farms specific to a commodity or discipline belonged to the second category, Agricultural Research Farms, under the Regional Agricultural Directorate. These farms engaged in three activities: providing technical backstopping to the extension program; conducting field experiments pertinent to the Central Research Program; and producing improved seeds, fruit plants, and animals.

Under reorganization, a new Department of Food and Agricultural Marketing Services was opened, and the Department of Irrigation, Hydrology, and Meteorology of the Ministry of Water and Power was brought under the Ministry of Food and Agriculture, which was renamed the Ministry of Food, Agriculture, and Irrigation. Three divisions, Planning and Coordination, Evaluation and Project Analysis, and Administration and Fiscal Management, and a Project Review Committee were established in the ministry.

A National Agricultural Development Committee, under the chairmanship of the minister of food, agriculture, and irrigation, was also set up to formulate agricultural policies and provide guidelines for agricultural development. Similarly, an Agricultural Research Coordination Committee was created under the chairmanship of the director general of the Department of Agriculture to provide guidelines for research policy and priorities. These committees remained dormant.

In 1979 a separate Department of Livestock Development and Animal Health was again created from the Department of Agriculture. This new department opened a Regional Directorate of Livestock Development and Animal Health in each development region of the country.

The internal organization of the Department of Agriculture was further changed in 1982, and research sections were brought under three deputy directors general (see Figure 2). The Agricultural Botany and Agronomy sections, eight agricultural stations, and the national commodity programs for six crops are now under the deputy director general of crop production, whereas the Soil Science and Agricultural Chemistry, Plant Pathology, Entomology, and Agricultural Engineering sections are under the deputy director general of technical services and extension. The development sections for fisheries, fruits, and vegetables and the national commodity programs for potatoes and citrus are under the deputy director general of horticulture and fisheries. Another interesting feature of the reorganization is that the Agricultural Information Section, which is closely related to extension, is not under the deputy director general of technical services and extension, but under the deputy director general of planning and evaluation. Also, some agricultural farms are under a regional agricultural directorate, although other regional directorates currently have no farms. The production support bias and the balance of work distribution among the deputy directors general seem to be the guiding factors in the current reorganization. Thus these compartmentalizations have further disintegrated agricultural research activities.

Present Agricultural Research Structure

The Ministry of Agriculture presently consists of the Department of Agriculture, the Department of Livestock Development and Animal Health, the Department of Food and Agricultural Marketing Services, and the Central Food Research Laboratory.

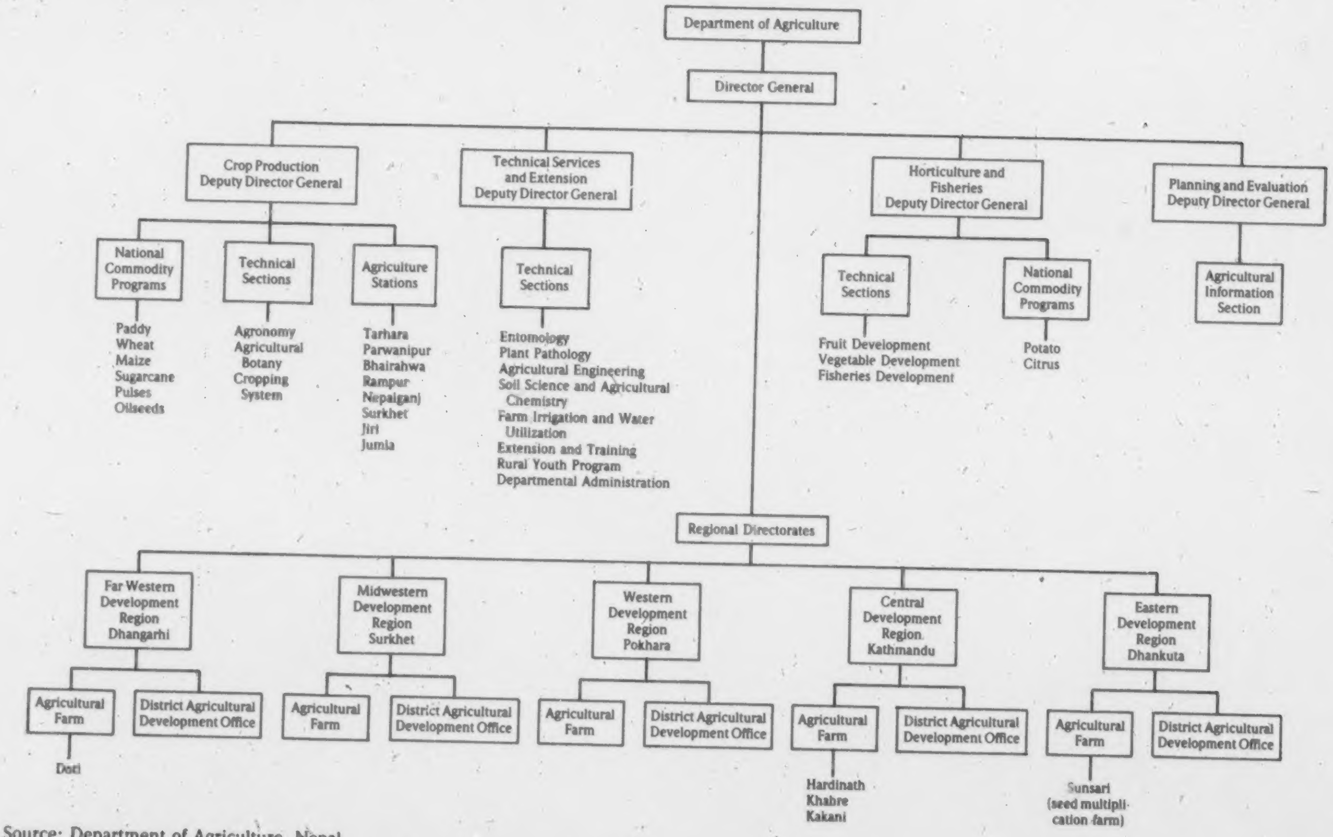
Department of Agriculture

Agricultural research within the Department of Agriculture is organized into disciplinary and commodity sections in addition to national commodity research programs. Agricultural research stations and agricultural farms have been established in various parts of the country for the purpose of research and production support programs (see Figure 3).

There are eight disciplinary sections: Agronomy, Agricultural Botany, Entomology, Plant Pathology, Soil Science and Agricultural Chemistry, Agricultural Engineering, Socioeconomic Research and Extension, and Farming Systems Research. These sections are located at Khumaltar, Kathmandu Valley. Along with the three commodity sections discussed below, they are the technical arms of the Department of Agriculture. The main functions of the disciplinary sections are to conduct and coordinate research activities in their respective disciplines at the research section, the head offices of commodity research programs, agricultural stations, and agricultural farms. The Agronomy Section carries out varietal and fertilizer trials and varietal improvement through plant breeding, and also does cropping system research. The Agricultural Botany Section does seed testing, inspection, and certification. The Plant Pathology Section conducts research on plant diseases and mushrooms. The Soil Science Section conducts soil tests and biogas research. The work of the Entomology Section includes sericulture and apiculture, besides research on insect pests of plants. The Socioeconomic Research and Extension Section conducts research on adoption of recommended technology, and the Farming Systems Research Section focuses on the suitability of technology, taking the total farming system into account.

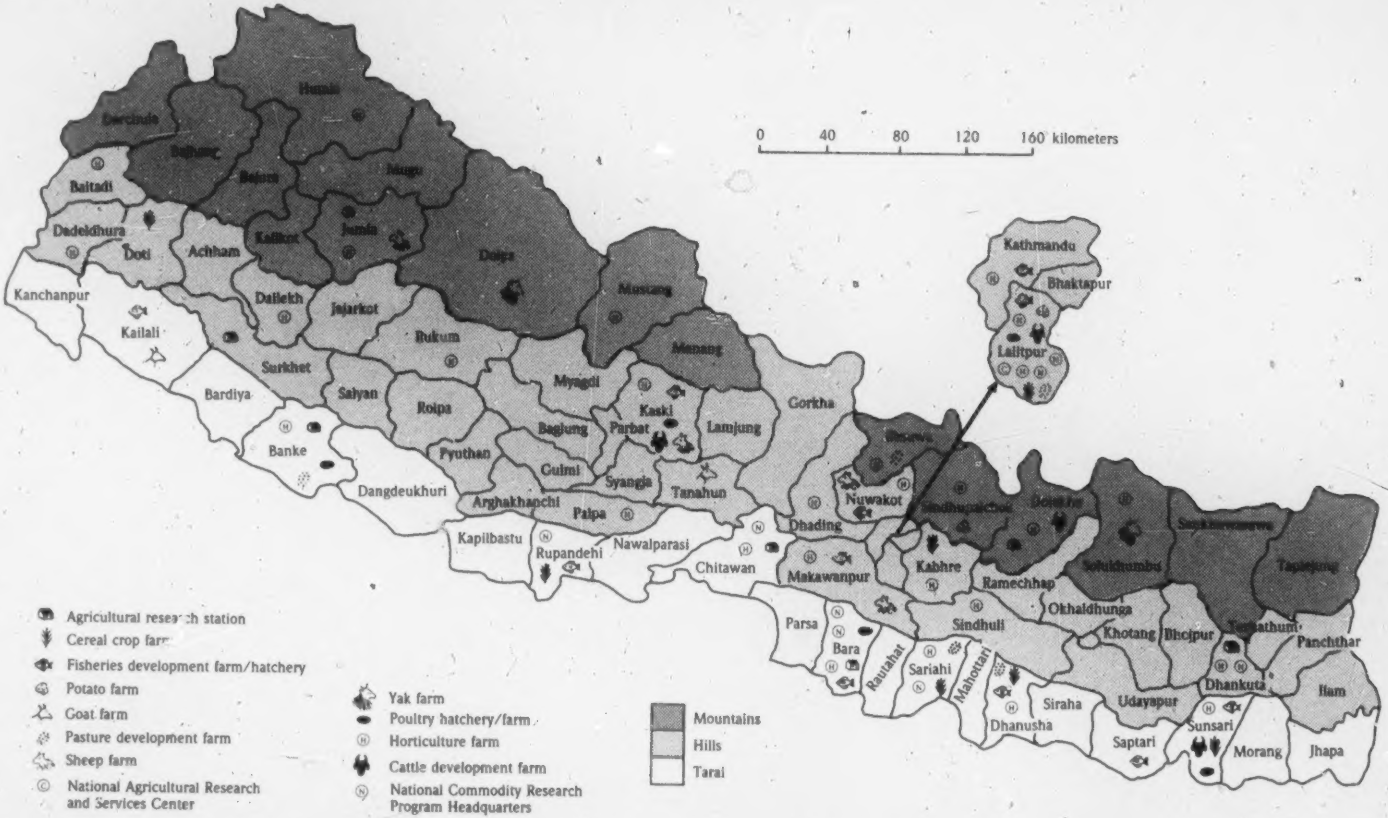
The three commodity sections are Fruit Development, Vegetable Development, and Fisheries Development. The fruit and vegetable sections are responsible for conducting and coordinating research and developmental activities in horticulture. These sections concentrate primarily on production and production-support activities. For fruits, some

Figure 2—Organization chart of the Department of Agriculture, 1982


Department of Agriculture
Director General
Crop Production Deputy Director General
National Commodity Programs
Paddy
Wheat
Maize
Sugarcane
Pulses
Oilseeds
Technical Sections
Agronomy
Agricultural Botany
Cropping System
Agriculture Stations
Tarhara
Parwanipur
Bhairahwa
Rampur
Nepalganj
Surkhet
Jiri
Jumla
Technical Services and Extension Deputy Director General
Technical Sections
Entomology
Plant Pathology
Agricultural Engineering
Soil Science and Agricultural Chemistry
Farm Irrigation and Water Utilization
Extension and Training
Rural Youth Program
Departmental Administration
Horticulture and Fisheries Deputy Director General
Technical Sections
Fruit Development
Vegetable Development
Fisheries Development
National Commodity Programs
Potato
Citrus
Planning and Evaluation Deputy Director General
Agricultural Information Section
Regional Directorates
Far Western Development Region Dhangarhi
Agricultural Farm
Doti
District Agricultural Development Office
Midwestern Development Region Surkhet
Agricultural Farm
District Agricultural Development Office
Western Development Region Pokhara
Agricultural Farm
District Agricultural Development Office
Central Development Region Kathmandu
Agricultural Farm
Hardinath
Khabre
Kakani
District Agricultural Development Office
Eastern Development Region Dhankuta
Agricultural Farm
Sunsari (seed multiplication farm)
District Agricultural Development Office

Source: Department of Agriculture, Nepal.

Figure 3—Locations of agricultural research stations and farms


0
40
80
120
160 kilometers
Darchula
Bajhang
Humla
Bajura
Mugu
Kalikot
Jumla
Dolpa
Mustang
Manang
Baitadi
Dadeldhura
Doti
Achham
Kanchanpur
Kailali
Dailekh
Jajarkot
Rukum
Surkhet
Bardiya
Salyan
Rolpa
Myagdi
Kaski
Parbat
Lamjung
Gorkha
Baglung
Banke
Pyuthan
Gulmi
Syangja
Tanahun
Dangdeukhuri
Arghakhanchi
Palpa
Kapilbastu
Rupandehi
Nawalparasi
Chitawan
Dhading
Nuwakot
Rasuwa
Sindhupalchok
Dolakha
Kabhre
Makawanpur
Ramechhap
Solukhumbu
Sankhuwasabha
Taplejung
Kathmandu
Bhaktapur
Lalitpur
Parsa
Bara
Rautahat
Sarlahi
Mahottari
Sindhuli
Okhaldhunga
Khotang
Bhojpur
Terhathum
Panchthar
Dhankuta
Ilam
Dhanusha
Siraha
Udayapur
Saptari
Sunsari
Morang
Jhapa
Agricultural research station
Cereal crop farm
Fisheries development farm/hatchery
Potato farm
Goat farm
Pasture development farm
Sheep farm
National Agricultural Research and Services Center
Yak farm
Poultry hatchery/farm
Horticulture farm
Cattle development farm
National Commodity Research Program Headquarters
Mountains
Hills
Tarai

Sources: Survey Department, Topographical Survey Branch, Nepal, 1982 (for map); and Ministry of Agriculture, Nepal, 1986 (for information about the farms).

research is carried out on varietal selection and propagation methods along with plant protection measures. For vegetables, quality seed production is the major activity; some varietal trials and plant protection trials are also conducted. In all, there are 26 horticultural farms and 4 horticultural units within the multipurpose agricultural stations at various locations in the hills and the Tarai. Only a few of them are truly engaged in research; they are Marpha, Jumla, Nawalpur, Yogyapuri, Nepalganj, Pokhara, Khumaltar, Kirtipur, and Dhankuta.

The Fisheries Development Section does research and developmental work for fisheries. Of the 11 fisheries development centers in the country, 6 are involved in some research work, but their main functions are to produce fingerlings and distribute them to farmers. The research activities of the centers include induced breeding techniques, incubation of fish eggs, limnological surveys of natural bodies of water, polyculture, integrated fish farming, and cage culture.

Eight national commodity research programs have been established to coordinate all research and production activities in a multidisciplinary approach. The program commodities and headquarters are shown below.

Crop	Headquarters
Paddy	Parwanipur
Wheat	Bhairahwa
Maize	Rampur
Potato	Khumaltar
Citrus	Khumaltar
Sugarcane	Jitpur
Pulses	Khumaltar
Oilseed	Nawalpur

Of these eight commodity research programs, the sugarcane, pulses, and oilseed programs are recent additions. Only the paddy, wheat, and maize programs are reasonably well established, with the financial and technical assistance of USAID, under the Integrated Cereals Project. The potato program has received some financial and technical assistance from the government of Switzerland. The responsibility for tobacco and cotton research had been with the Ministry of Industry but was recently transferred to the Department of Agriculture. Jute research is still with the Ministry of Industry.

Eight agricultural stations have been established in different agroclimatic areas for research and development activities. They are located in Tarhara, Dhankuta (headquarters of the citrus development program), Parwanipur, Rampur, Jiri, Nepalganj, Jumla, and Surkhet. These stations are centers of multipurpose activities and provide support services to extension through training and technical backstopping in addition to research. They essentially provide links between various national commodity research programs, central disciplinary sections, extension agencies, and farmers. The headquarters of some of the commodity programs are located at these stations, which also serve as testing sites for the programs and for disciplinary sections. Additionally, they are used for on-the-job training of extension workers and farmers.

Agricultural farms are established to concentrate on a single commodity or activity. For example, there are agricultural farms that deal only with cereal crops; horticultural farms deal only with fruits and vegetables. For cereal crops, 7 farms are engaged in adaptive research, seed multiplication, and other production support activities. They are Hardinath, Nawalpur, Bhairahwa, Khavre, Doti, Jhumka, and Khumaltar.

The cropping system program was initiated in 1977 after the recognition that each commodity research program and disciplinary section was concerned with solving a specific problem or developing a high-yielding variety without considering the work in the context of differences in cropping patterns, resource endowments, or socioeconomic levels of farmers. Also, the farming system in Nepal is a mixed-enterprise system, so the purpose of cropping system research is to test improved technologies under the conditions encountered by small farmers, and then to recommend appropriate technologies based on the farmers' cropping patterns. The cropping system research activities are conducted on farmers' fields at six different sites in Nepal.

For the hills, the research sites are Lele (Lalitpur), Pumdi Bhumdi (Kaski), Chaurjahari (Rukum), Khadbari (Sankhuwasawa), and in the Tarai, Sukhchaina (Parsa), and Tandi (Chitawan).[19] The program also carries out socioeconomic surveys to analyze factors affecting the adoption of improved technology and to identify the constraints of such adoptions. This program has developed methodologies of on-farm research that are useful to commodity programs and cropping systems, and to extension in carrying out production programs. The cropping system program will gradually expand to conduct a study for a total farming system, including livestock and other economic activities of farmers.

With the goal of improving the organization of research units, the Seventh Five-Year Plan (1985-90) made provision for the National Agricultural Research and Services Center (NARSC), which came into existence on December 31, 1985. NARSC's basic objective is to bring the different research activities of the Department of Agriculture together under one agency to provide coordination in research. The research units under NARSC are disciplinary and commodity sections, national commodity research programs, and agricultural stations and farms located in various parts of the country.

The functions of NARSC are to prepare short- and long-term research programs for submission to the National Agricultural Research Coordination Committee (NARCC); to execute, monitor, and supervise the programs approved by NARCC; to publish technical papers of research results; to prepare manpower and physical resource inventories for the operating and development plans of the research units; to set up a well-organized library; and to establish an Office of Biometrics to guide research centers and their staff in sound biometrical procedures for research. Since NARSC is in the Department of Agriculture, its coordination of research programs is restricted to field crops, horticultural crops, and fisheries.

Department of Livestock Development and Animal Health

The Department of Livestock Development and Animal Health has two main centers headed by two deputy directors general. The Livestock Development Center has five sections: Animal Nutrition, Animal Breeding, Animal Pasture and Fodder, Poultry, and Animal Production and Management. The Animal Health Center also has five sections: Biological Products for Production of Vaccines, Disease Investigation and Research Laboratory, Rabies Control, Foot-and-Mouth Disease, and Central Veterinary Hospital. Nepal has four cattle development farms, two yak farms, three sheep farms, two goat farms, five brooder hatcheries, and four pasture crop development farms. Research activities in livestock are limited. Livestock farms are largely concerned with the production of superior livestock breeds and their distribution. The only unit that carries out some veterinary research is the Disease Investigation and Research Laboratory. Livestock farms conduct very limited research in animal nutrition and breeding.

Department of Food and Agricultural Marketing Services

Economic and marketing analysis in agriculture is conducted by the Department of Food and Agricultural Marketing Services (DFAMS). DFAMS has three divisions: Economic Analysis, Agricultural Marketing Services, and Agricultural Statistics. Only the Economic Analysis Division is engaged in some socioeconomic research.

Central Food Research Laboratory

The Central Food Research Laboratory is a separate agency with the status of a department in the Ministry of Agriculture. Its major activities are related to regulating such functions as food testing and quality control by fixing certain minimum quality and purity standards for different food products. The agency also conducts some research on fruit and vegetable processing in Kathmandu and analyzes the nutritional value of different foods and food products.

---

[19] The names in parentheses are the districts in which the research sites are located.

Other Research Institutes

Other institutes engaged in agricultural research are the Institute of Agriculture and Animal Sciences (IAAS) at Rampur, under Tribhuvan University, and the Agricultural Projects Services Center (APROSC) in Kathmandu. IAAS conducts both physical and social science research, whereas APROSC is mainly concerned with research related to project formulation, evaluation, and agricultural policy.

The fragmentation of agricultural research is further illustrated in the conduct of irrigation management research by the Department of Irrigation, Hydrology, and Meteorology in the Ministry of Water Resources; soil conservation and erosion control research by the Department of Soil Conservation and Watershed Management; and silviculture research by the Department of Forestry in the Ministry of Forestry and Soil Conservation (MFSC). The Department of Medicinal Plants is the largest unit under MFSC to be involved in research. It has four sections: Royal Drug Research Laboratory, Royal Botanical Garden, Botanical Survey and Herbarium, and Herbal Farms.

Research Planning

Each technical (disciplinary or commodity) section and national commodity research program is required to prepare its annual program along with its annual budget for presentation to the National Planning Commission and the Ministry of Finance. The inputs from crop workshops that are held twice yearly (in January for summer crops and in August for winter crops) are used in preparing the annual programs. The research achievements and planned activities of the commodity research program and those of the technical section that are related to the commodity program are discussed in the workshops. The comments and suggestions of the workshops are solicited to modify certain activities in the proposed programs. The workshops are attended by the joint secretaries of the Ministry of Agriculture, the director general and deputy directors general of the Department of Agriculture, regional directors, the chiefs of technical sections and commodity programs, and a group of district agricultural development officers. Representatives of the Agriculture Inputs Corporation, the Agricultural Development Bank, the Department of Food and Agricultural Marketing Services, IAAS, and APROSC are also invited.

The annual research programs thus prepared by technical sections and commodity programs are submitted to the Department of Agriculture. These research programs are subsequently submitted to and discussed in the Ministry of Agriculture and are then passed to the National Planning Commission and the Ministry of Finance for further discussion and budget approval.

The planning procedure using inputs from the workshops is largely restricted to main cereal and cash crops. Since the research programs for fruits, vegetables, livestock, and fisheries are limited, they are not subjected to this rigorous planning procedure.

The current target-oriented programming and evaluation has led to an undervaluation of the importance of research in agricultural stations and farms. For example, each farm is required to fix targets for production of seeds, animals, or fingerlings and for the number of persons to be trained or training courses to be conducted every year. Similarly, a target is set for the number of research experiments to be conducted. These targets are broken down on a quarterly basis and farms are expected to report in their quarterly evaluation the number of research experiments carried out and other targets achieved. Thus a farm with multiple functions can achieve 70 to 80 percent of its targets, showing a good performance without doing research. This problem is due not only to the low priority accorded to research but also to a faulty evaluation system based on physical targets.

Research Coordination

The Agricultural Research Coordination Committee, constituted in 1972/73 under the chairmanship of the director general of the Department of Agriculture, was reestablished in 1980/81 under the chairmanship of the secretary of agriculture but remained inactive. The other committee members named were the joint secretary of the Evaluation and Project Analysis Division of the Ministry of Agriculture; the joint secretary (agriculture) of the National Planning Commission; the director general of the Department of Livestock Development and Animal Health; the deputy director general (crop research) of the Department of Agriculture; the deputy director general of the Department of Food and Agricultural Marketing Services; the chief of the Central Food Research Laboratory; subject matter specialists in the fields of crop science, agricultural botany, horticulture, plant protection, livestock and veterinary science, fisheries, agricultural engineering, and farm irrigation; and two farmers' representatives.

The designated functions of the research committee were to determine agricultural research priorities and policies; to approve research projects submitted by research agencies after ascertaining that the projects are consistent with research priorities and policies; to provide the necessary financial and personnel resources to carry out the projects effectively; to conduct regular monitoring and evaluations of research projects; and to initiate contacts and develop relations with other national and international agencies in the field of agricultural research. No separate secretariat was ever established for this committee.

The need for an effective and functioning research coordination committee at the national level to streamline the agricultural research system was again recognized in the Seventh Five-Year Plan (1985-90). Therefore, the existing Agricultural Research Coordination Committee has been reconstituted and renamed the National Agricultural Research Coordination Committee (NARCC) under the chairmanship of the secretary of the Ministry of Agriculture. The other committee members are the joint secretaries of the Planning and Coordination Division of the Ministry of Agriculture, the National Planning Commission (agriculture), the Ministry of Finance, and the Ministry of General Administration; the directors general of the Department of Agriculture, the Department of Livestock and Animal Health, and the Department of Food and Agricultural Marketing Services; representatives from the Royal Nepal Academy of Science and Technology and the Institute of Agriculture and Animal Science of Tribhuvan University; the chiefs of the Central Food Research Laboratory and the National Agricultural Research and Services Center; two farmers' representatives; and three representatives from a group of eminent scientists.

A permanent secretariat of the committee has been established in the Ministry of Agriculture. There is now a provision for a full-time member secretary (joint-secretary level) who also acts as the chief executive officer and has a panel of technical personnel and supporting staff.

Donor Assistance and Research Collaboration

Apart from greater national effort, two other important factors can help build the national research system: external assistance and collaboration with other national and international research systems.

Project Versus Program Assistance

Generally, external agencies support agricultural research on the basis of a project, rather than a program, approach. This causes both distortions in the resource allocations and conflict among project staff and nonproject staff due to differences in opportunities and privileges throughout a project. For instance, under the Integrated Cereals Project, USAID support was limited to three major foodgrain crops, namely, paddy, wheat, and maize, and was not extended to livestock and horticulture. Dr. Vernon W. Ruttan, whose work in the field of agricultural research systems is well known, contends that "the project support approach to agricultural development assistance has rarely been effective in contributing to the development of viable national agricultural development institutions."[20] There are currently 32 foreign-aided projects supported by 13 different external agencies to help in agricultural research, resource assessment, and data acquisition in Nepal (see Appendix I, Table 40).

USAID has been the major donor agency to support agricultural research in Nepal. From 1957 to 1984, USAID contributed about U.S. $23 million to assist in establishing research and extension systems, with the main emphasis on foodgrain crops, through technical assistance, equipment and material, and training. The *Report of the IFAD Special Programming Mission to Nepal* emphasizes development of fruit and livestock to effect a shift toward an appropriate balance among commodities.[21] To bring about a balanced development of the total agricultural research system, a long-term comprehensive plan for agricultural research in terms of its structure, physical facilities, and staff development needs to be prepared. Similarly, the commitment of funds on a long-term basis to implement such a plan needs to be sought.

Collaboration with External Research Systems

Nepal's collaboration with other national and international agricultural research systems is extremely limited. One reason for this limitation is the weak Nepalese research system. Unless the level of research and scientific staff improves, it will be difficult, if not impossible, to establish and maintain contacts with other systems and to realize mutual benefit for collaborators. Nepal could benefit greatly from collaboration with the Indian agricultural research system, which is relatively well developed in the region, but only the Nepalese wheat, rice, and sugarcane programs have established contacts with the respective programs in India. Even these contacts were initiated entirely on a personal basis among the scientists. Useful collaboration could also be established with India in many other areas of crops, livestock, and horticulture. Other collaborators include the Asian Regional Maize Program in Thailand and at the University of Hawaii, and the International Winter Wheat Nursery Program at the University of Nebraska in the United States.

As for contacts with the international agricultural research centers, Nepal has some collaboration with the International Rice Research Institute (IRRI) and the International Center for Maize and Wheat Improvement (CIMMYT), but only limited collaboration with the International Potato Center (CIP), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), the International Center for Agricultural Research in the Dry Areas (ICARDA), and the International Food Policy Research Institute (IFPRI). Exchanges of germplasm and visits of scientists between Nepal and these international centers have taken place. Some Nepalese research scientists have also received short-term training at IRRI and CIMMYT.

Comparison with Neighboring Research Systems

Compared with the agricultural research systems of India, Pakistan, and Bangladesh, which are organized under autonomous councils, the Nepalese system has three important distinguishing features. First, the Nepalese agricultural research system operates under government departments within the rules and regulations of the civil service. Second, Nepal's research units or activities are not unified under one body, but operate separately within different departments of the government and have serious problems of coordination. Third, the research sections, commodity research programs, and agricultural stations and farms are entrusted with responsibilities of both research and development (production support) activities.

---

[20] Vernon W. Ruttan, "Reforming the Global Agricultural Research Support System," *Bulletin 83-2,* Economic Development Center, University of Minnesota, March 1983.

[21] International Fund for Agricultural Development, *Report of the Special Programming Mission to Nepal* (Rome: IFAD, 1979).

Need for Social Scientists

An important factor missing in the present research system is the involvement of social scientists with biological scientists in agricultural technology development. There is no social scientist working with any disciplinary or commodity section, commodity research program, or farming research unit anywhere in the country. A single Nepalese agricultural economist who had worked with a farming system research unit returned recently from IRRI after completing his Ph.D. In the development of improved technology, omission of the socioeconomic aspect is a serious constraint in recommending technology consistent with farmers' problems and resource endowments. The need for social scientists to work closely with physical and biological scientists has recently been recognized.

5

ALLOCATION OF FINANCIAL AND PERSONNEL RESOURCES FOR RESEARCH

The agricultural sector includes agriculture, irrigation, forestry, land reform, and cadastral survey. From 1970/71 to 1980/81, the rate of annual increase in expenditure on the agriculture component was only 11 percent in real terms, compared to 15 percent on irrigation and 19 percent on forestry. During the same period, the agriculture expenditure constituted about 42 percent of the total agricultural sector budget (calculated from Table 9). The average shares of expenditure on agriculture as a percentage of agricultural GDP and of development expenditure were 1.2 and 10.2 percent, respectively.

Real expenditure in agricultural research increased annually at about 4 percent, from Rs 14.5 million in 1970/71 to Rs 18 million in 1980/81 (see Table 10). Similarly, real expenditure in agricultural extension increased annually about 7 percent from Rs 6.3 million in 1970/71 to Rs 10.9 million in 1980/81.

Table 11 presents the average shares and annual growth rates of expenditure on research, by discipline, between 1970/71 and 1980/81. Crops, livestock, and horticulture together constituted 81 percent of the total expenditure. Though the expenditure on socioeconomic research constituted the lowest share, its annual growth rate has been the highest (12.5 percent) because of a low base value. On the other hand, crop research constituted the highest share (37 percent), but its growth rate was the lowest (less than 3 percent). The real expenditure on input research, which comprised expenditures in the agricultural engineering section, soil science, and agricultural chemistry, declined during this period. The annual

Table 9—Agricultural sector budget expenditures, 1970/71-1980/81

Year	Irrigation	Forestry	Land Reform and Cadastral Survey	Agriculture	Total Agricultural Sector
			(1972/73 Rs million)		
1970/71	42.2	10.0	8.8	45.53	106.6
1971/72	49.8	14.7	9.2	45.07	118.7
1972/73	34.3	13.2	11.0	61.81	120.3
1973/74	68.4	14.3	10.6	75.03	168.3
1974/75	55.2	18.0	15.3	66.12	154.6
1975/76	69.5	26.2	16.3	146.92	259.0
1976/77	90.0	31.7	22.3	128.55	272.5
1977/78	91.9	48.9	22.1	121.55	283.7
1978/79	140.5	41.5	28.3	122.00	332.3
1979/80	131.0	53.0	20.8	86.44	291.3
1980/81	143.1	44.3	21.1	127.59	336.1
			(percent)		
Annual growth rate	14.89	18.89	11.85	10.95	13.56
t-statistic	8.06	9.77	6.68	3.87	9.13

Source: Nepal, Ministry of Finance, *Budget Speeches,* various fiscal years (Kathmandu: MOF, various years).
Note: Irrigation, forestry, land reform and cadastral survey, and agriculture are the components of the agricultural sector.

Table 10—Budget expenditures on agricultural research and extension and other agricultural items, 1970/71-1980/81

Year	Agricultural Research	Agricultural Extension	Other Agricultural Expenditures[a]	Total Agriculture
		(1972/73 Rs million)		
1970/71	14.468	6.308	24.75	45.53
1971/72	14.456	8.626	21.99	45.07
1972/73	14.280	8.503	39.03	61.81
1973/74	15.966	8.534	50.53	75.03
1974/75	16.031	7.661	42.43	66.12
1975/76	18.693	11.196	117.03	146.92
1976/77	20.162	13.745	94.64	128.55
1977/78	20.024	13.325	88.20	121.55
1978/79	21.814	15.087	85.10	122.00
1979/80	19.351	13.188	53.90	86.44
1980/81	18.079	10.859	98.65	127.59
		(percent)		
Annual growth rate	3.92	7.16	14.35	10.95
t-statistic	4.61	4.18	3.70	3.97

Source: Nepal, Auditor General's Office, *Auditor General Annual Report*, various issues (Kathmandu: AGO, various years).

[a] Includes expenditures on administration and subsidies on seed, fertilizer, credit, and food distribution.

Table 11—Agricultural research expenditures, by discipline, 1970/71-1980/81

Year	Crop Research	Livestock Research	Horticultural Research	Fisheries Research	Input Research	Food Research	Socioeconomic and Marketing Research
				(1972/73 Rs million)			
1970/71	5.624	4.269	1.627	1.232	0.898	0.556	0.260
1971/72	6.476	3.129	1.989	0.974	0.992	0.533	0.362
1972/73	5.791	3.222	2.598	0.900	0.676	0.914	0.179
1973/74	5.181	3.747	3.345	1.049	1.052	1.182	0.409
1974/75	5.141	3.647	4.127	1.049	0.778	0.663	0.626
1975/76	6.214	3.670	4.649	2.188	0.615	0.812	0.544
1976/77	7.536	3.883	4.739	1.858	0.758	0.733	0.654
1977/78	7.206	4.108	4.884	1.424	0.820	0.805	0.777
1978/79	8.858	4.217	4.713	1.590	0.851	0.894	0.691
1979/80	6.318	5.541	3.878	1.361	0.774	0.791	0.688
1980/81	6.678	4.532	3.555	1.288	0.538	0.783	0.704
Annual average	6.457	3.993	3.642	1.355	0.796	0.788	0.536
				(percent)			
Average share	37.00	23.00	21.00	8.00	4.50	4.50	3.00
Growth rate	2.84	3.34	8.78	4.13	−3.03	2.35	12.47
t-statistic	2.06	2.84	3.35	1.67	−1.83	1.08	4.26

Source: Calculated from Nepal, Auditor General's Office, *Auditor General Annual Report*, various issues (Kathmandu: AGO, various years).

Note: The detailed components of these classifications are presented in Appendix 1, Tables 41 through 46.

growth rate of real expenditure for horticulture was 9 percent; livestock, 3 percent; fisheries, 4 percent; and food, 2 percent.

Between 1970/71 and 1980/81, the expenditure on agricultural research in the hills increased from Rs 5.6 million to Rs 7.4 million at 6 percent annually, while the expenditure in the Tarai (where fisheries research is concentrated) increased from about Rs 5.7 million to Rs 6.6 million, at an annual rate of 3 percent (see Table 12). Expenditures for crop, horticulture, and livestock research in the hills increased at 8, 9, and 4 percent a year, respectively (see Table 13). Thus it is evident that during the 1970s, hill agricultural research was accorded a high priority.

Real expenditures on the single-discipline research programs of the technical sections increased by only 2 percent annually during the same period, from Rs 3 million to Rs 4 million.

Annual budget expenditures of technical sections, agricultural stations, and farms fluctuated widely during this period, and in most cases their expenditures in real terms were constant or declined, particularly after 1975/76 (see Appendix 1, Tables 41-46).

Table 12—Agricultural research expenditures on hill, Tarai, and disciplinary research, 1970/71-1980/81

Year	Tarai	Hill	Disciplinary	Total
		(1972/73 Rs million)		
1970/71	5.734	5.569	3.163	14.466
1971/72	6.127	4.917	3.412	14.456
1972/73	6.219	4.997	3.064	14.280
1973/74	5.817	6.086	4.063	15.966
1974/75	5.712	6.376	3.943	16.031
1975/76	7.382	7.788	3.523	18.693
1976/77	8.277	7.801	4.084	20.162
1977/78	7.988	8.028	4.008	20.024
1978/79	9.000	8.523	4.291	21.814
1979/80	6.816	8.823	3.712	19.351
1980/81	6.642	7.440	4.000	18.078
		(percent)		
Growth rate	3.02	5.74	2.33	3.93
t-statistic	2.38	5.43	2.79	4.61

Source: Calculated from Nepal, Auditor General's Office, *Auditor General Annual Report*, various issues (Kathmandu: AGO, various years).

Agricultural research expenditure as a share of agricultural GDP has remained around 0.22 percent between 1970/71 and 1980/81 (see Table 14). However, agricultural research expenditure as a share of total development expenditure declined from 2.76 percent in 1970/71 to 1.33 percent in 1980/81. Similarly, agricultural research as a share of the agricultural sector and agriculture budget expenditures declined substantially from 13.60 and 31.77 percent, respectively, in 1970/71 to 5.40 and 14.17 percent in 1980/81. The proposed research expenditure as a share of the agriculture component for the Sixth Five-Year Plan (1980-85) shows a further decline to only 8.0 percent (see Table 15).

The money and personnel used in the technical sections, research stations, commodity research programs, and agricultural farms are categorized as research expenditures in government budget documents, although the real research expenditure is less (see Table 16). For analysis purposes, the budgeted research expenditure and the actual research expenditure are separated. What the government considers research expenditure, which is generally reported, has been termed "budgeted" research expenditure, while expenditure on activities that would qualify as actual research work has been termed "actual" research expenditure. The actual research expenditure was estimated as the expenditure that is made exclusively for research purposes from total budget expenditure in the technical sections, commodity research programs, agricultural stations, and farms. A three-year average (1978/79-1980/81) of the total budgeted research expenditure was about Rs 35.4 million, of which crop research constituted 38 percent; livestock, 24; horticulture, 20; fisheries, 7; food, 4; socioeconomic, 4; and input, 3 percent. The average budgeted recurrent research expenditure was about 26.6 million, which was 75 percent of the budgeted research expenditure for the three years. The estimated

Table 13—Agricultural research expenditures, by region and discipline, 1970/71-1980/81

Year	Tarai				Hill			
	Crops	Horticulture	Livestock	Fisheries	Crops	Horticulture	Livestock	Fisheries
				(1972/73 Rs million)				
1970/71	3.592	0.444	1.016	0.682	0.583	1.183	3.253	0.550
1971/72	4.222	0.450	0.849	0.606	0.730	1.539	2.280	0.368
1972/73	4.102	0.449	0.984	0.684	0.394	2.149	2.238	0.216
1973/74	3.411	0.518	1.094	0.793	0.586	2.827	2.418	0.256
1974/75	2.986	0.892	1.092	0.742	0.628	3.234	2.207	0.307
1975/76	4.134	1.300	0.893	1.055	0.887	3.349	2.420	1.133
1976/77	5.030	0.994	1.093	1.160	1.209	3.745	2.148	0.698
1977/78	5.062	0.950	0.962	1.014	1.069	3.934	2.614	0.411
1978/79	5.929	1.102	0.811	1.159	1.497	3.611	2.983	0.431
1979/80	4.240	0.798	0.544	1.234	0.999	3.080	4.616	0.127
1980/81	4.256	0.797	0.680	0.908	0.796	2.762	3.501	0.380
				(percent)				
Growth rate	3.03	8.75	−4.12	6.37	8.20	8.90	3.87	−2.04
t-statistics	1.79	2.99	−2.45	4.27	2.79	3.25	1.84	−0.35

Source: Calculated from Nepal, Auditor General's Office, *Auditor General Annual Report*, various issues (Kathmandu: AGO, various years).

Table 14—Agricultural research expenditure as a share of agricultural GDP and of expenditures on development, agricultural sector, and agriculture, 1970/71-1980/81

Year	Agricultural Research Expenditure Shares			
	Agricultural GDP	Total Development Expenditure	Agricultural Sector Expenditure	Agriculture Expenditure
		(percent)		
1970/71	0.19	2.76	13.6	31.77
1971/72	0.16	2.31	12.2	32.07
1972/73	0.19	2.35	11.9	23.10
1973/74	0.18	2.43	9.5	21.28
1974/75	0.19	2.22	10.4	24.25
1975/76	0.23	2.13	7.2	12.72
1976/77	0.28	1.90	7.3	15.68
1977/78	0.27	1.73	7.1	16.47
1978/79	0.26	1.78	6.6	17.88
1979/80	0.25	1.49	6.6	22.39
1980/81	0.23	1.33	5.4	14.17

Sources: Nepal, Auditor General's Office, *Auditor General Annual Report*, various issues (Kathmandu: AGO, various years); and Nepal, Ministry of Finance, *Budget Speeches*, various fiscal years (Kathmandu: MOF, various years).

Note: The agricultural sector comprises agriculture, irrigation, forestry, land reform, and cadastral survey.

Table 15—Proposed expenditures for agricultural research and extension in the Sixth Five-Year Plan (1980-85)

Category	Research	Extension	Total Research and Extension
		(Rs million)	
Foodgrains	102.0	428.9	530.9
Cash crops	16.3	10.8	27.1
Horticulture	35.6	24.3	59.9
Special programs	. . .	100.0	100.0
Livestock	21.7	443.5	465.2
Fisheries	8.1	37.0	45.1
Total	183.7	1,044.5	1,228.2

Source: Nepal, National Planning Commission, *The Sixth Five-Year Plan* (1980-85) (Kathmandu: NPC, 1981).
Note: Total proposed agriculture expenditure was Rs 2,300 million.

actual research expenditure was only Rs 12.5 million, which was about 35 percent of the budgeted research expenditure. Similarly, the actual recurrent research expenditure was only Rs 8.5 million, or about 32 percent of the budgeted recurrent research expenditure. Of the estimated actual research expenditure, crop research constituted 69 percent and other categories amounted to less than 10 percent each.

The estimated actual research expenditure for individual crops is shown in Table 17. The research on cereal grain crops accounted for about 80 percent of all research expenditure on farm crops. The share of three main cereal grains—paddy, wheat, and maize—is 80 percent of the total value of all farm crops and 82 percent of the total cropped area. This implies perfect congruity in research allocation for cereal grains. The congruity index computed for all farm crops is 0.90, which is high, indicating a fair allocation of research resources among commodities. However, when the research allocation is examined for each commodity with respect to its contribution to agricultural GDP, the research expenditure for paddy appears to be comparatively low. Paddy alone constituted about 50 percent of the total value of all crops and 51 percent of the total cropped area, but accounted for only 23 percent of total research expenditure and only 19 percent of operating expenses. Research expenditure per million rupees of paddy production is the lowest for any crop, at only Rs 383. The recurrent research expenditure per million rupees of paddy production is even lower, at Rs 194.

Wheat research has received more favorable support, since it accounted for only 13 percent of the total value of crops but received 23 percent of the crop research resources.

Among cash crops, tobacco received the highest research allocation, accounting for only 1 percent of the total value of crops but receiving 6 percent of the crop research resources. The research expenditure per million rupees of tobacco production was Rs 4,883. Low budgetary allocation to sugarcane research was aptly described by the sugarcane coordinator:

> The sugarcane program is virtually a one-man program at present. Some posts are lying vacant due to study leave, deputation to other places, or transfer of the concerned personnel. Other posts are serving now as shunting stations for personnel with temporary appointments. Frequent changes of staff make no fruitful contribution to the program. Under such circumstances, quality research work cannot be done, nor is it possible to undertake essential research tasks. An annual budget of Rs 300,000-600,000, mostly covering salary, is absolutely inadequate for running the research projects of utmost need.[22]

---

[22] Arun Kumar Rai, *National Report on Sugarcane—1982/83* (Kathmandu: National Sugarcane Development Programme, Department of Agriculture, 1983).

Table 16—Budgeted and actual research expenditures, 1978/79-1980/81 average

Category	Budgeted Research Expenditure	Percentage of Budgeted Research Expenditure	Budgeted Recurrent Research Expenditure[a]	Percentage of Budgeted Recurrent Research Expenditure[a]	Actual Research Expenditure	Percentage of Actual Research Expenditure	Actual Recurrent Research Expenditure[a]	Percentage of Actual Recurrent Research Expenditure[a]
	(Rs 1,000)		(Rs 1,000)		(Rs 1,000)		(Rs 1,000)	
Crops	13,047	38	8,821	33	8,639	69	5,187	61
Livestock	8,587	24	5,826	22	859	7	583	7
Horticulture	7,216	20	6,382	24	1,082	9	957	11
Fisheries	2,525	7	1,935	7	202	2	155	2
Food	1,474	4	1,317	5	590	5	527	6
Socioeconomic	1,252	4	1,227	5	789	6	773	9
Input	1,276	3	1,062	4	306	2	255	3
Total	35,377	100	26,570	100	12,467	100	8,437	100

Sources: Calculated from Nepal, Auditor General's Office, *Auditor General Annual Report,* various issues (Kathmandu: AGO, various years); and Nepal, National Planning Commission, *Agriculture Plans and Programs for 1982/83* (Kathmandu: NPC, 1982).

Note: The 1982/83 plan provides the annual budget and the work plan for each unit and program, along with the weightage of different activities to be carried out under them. The proportion of the research expenditure in each sector is calculated as a weighted average: livestock, 10 percent; horticulture, 15 percent; fisheries, 8 percent; food, 40 percent; socioeconomic, 63 percent; and input research, 24 percent. The actual research expenditure for crops was estimated differently (see Appendix 1, Table 41).

[a] Recurrent expenditures are labor and operating expenses.

Table 17—Average total research expenditure and recurrent expenditure, by commodity, 1978/79-1980/81

Commodity	Actual Research Expenditure	Percentage of Actual Research Expenditure	Research Expenditure per Million Rupees of Value of Production	Share of Each Crop in Total Value of All Crops	Share of Each Crop in Total Area of All Crops	Recurrent Research Expenditure[a]	Percentage of Recurrent Research Expenditure[a]	Recurrent Research Expenditure per Million Rupees of Value of Production[a]
	(Rs 1,000)		(Rs)	(percent)		(Rs 1,000)		(Rs)
Paddy	1,958	23.0	383	49.5	50.1	990	19	194
Wheat	1,946	23.0	1,477	12.8	15.0	1,030	20	782
Maize	2,809[b]	33.0[b]	1,289[b]	18.1	17.3	1,628[b]	31[b]	745[b]
Millet				3.0	4.9			
Barley	...	...	...	0.6	1.1	...	...	...
Potato	397	4.0	583	6.6	2.1	306	6	450
Sugarcane	348	4.0	3,071	1.1	0.9	289	6	2,551
Oilseed	409	5.0	803	4.9	5.8	262	5	521
Jute	...	...	...	1.7	1.8	...	...	...
Tobacco	521	6.0	4,883	1.0	0.3	505	10	4,733
Tea	...	...	...	0.1	0.1	...	...	...
Ginger	46	0.5	912	0.5	...	46	1	912
Cardamom	206	2.0	9,075	0.2	...	131	2	5,771
Total	8,640	100.0[c]	837[d]	100.0[c]	100.0[c]	5,187	100	502[d]

Sources: Computed from Nepal, Auditor General's Office, *Auditor General Annual Report,* various issues (Kathmandu: AGO, various years); and unpublished data on area and production from the Department of Food and Agricultural Marketing Services, Nepal.

Notes: Research expenditure is the average of three years: 1978/79, 1979/80, and 1980/81. Total value of all crops is the average of two years: 1978/79 and 1980/81. The year 1979/80 is omitted because it was a famine year.

[a] Recurrent expenditures are labor and operating expenses.

[b] Combined figure for maize and millet.

[c] Parts do not add to total because of rounding.

[d] Expenditure per million rupees of all crops.

The research expenditure per million rupees of all crops was Rs 837, while the recurrent research expenditure per million rupees of all crops was Rs 502.

The total budgeted agricultural research expenditure was about 0.25 percent of the agricultural GDP (see Table 18). However, the actual research expenditure was only about 0.10 percent of the agricultural GDP. Thus the budgeted research expenditure is highly overestimated compared to the actual expenditure.

An IFPRI/ISNAR study indicates that the average level of agricultural research investment in relation to agricultural GDP for 51 developing countries was 0.56 percent for 1980.[23] A desirable investment target for research in countries with poorly developed agricultural research systems would be an annual expenditure equivalent to about 2 percent of agricultural domestic product.[24] Nepal compares poorly with other developing countries in this regard.

The total budgeted research expenditures were 6.61 percent of the agricultural sector expenditure and 17.48 percent of the agriculture component expenditure, whereas the actual research expenditures were only 2.39 and 6.80 percent, respectively (Table 18).

Capital, Staff Salaries, and Operating Expenses

The components of the research budget expenditure in terms of capital, staff salaries and allowances, and other operating expenses are analyzed in this study. On average, from 1970/71 to 1980/81, capital expenditure constituted 29.6 percent, staff salaries were 36.6 percent, and other operating expenses amounted to 33.80 percent of agricultural research expenditure. However, the share of capital expenditure declined from 45.9 percent in 1970/71 to 21.6 percent in 1980/81, while the shares of staff salaries and other operating expenses increased from 25.2 and 28.9 percent to 42.7 and 35.7 percent, respectively.

A declining trend in capital expenditure and an increase in recurrent expenditure implies that some basic minimum physical infrastructure has been built over the years. Almost 75 percent of the research cost was recurrent expenditure. Of the recurrent costs, on average, salary constituted 55 percent in crops, 34 percent in livestock, and 63 percent in horticulture. In the case of livestock, most of the recurrent expenditure was incurred for the purchase of feed and veterinary medicines for livestock.

Table 18—Budgeted and actual research expenditure as a share of agricultural GDP and of expenditures on development, the agricultural sector, and agriculture, 1978/79-1980/81 average

	Research Expenditure Shares			
Category	Agricultural GDP	Development Expenditure	Agricultural Sector Expenditure[a]	Agriculture Expenditure
		(percent)		
Total budgeted research expenditure	0.25	1.51	6.61	17.48
Total actual research expenditure	0.10	0.59	2.39	6.80

Sources: Calculated from Nepal, Ministry of Finance, *Budget Speeches*, various fiscal years (Kathmandu: MOF, various years); Nepal, Auditor General's Office, *Auditor General Annual Report*, various issues (Kathmandu: AGO, various years); Nepal, National Planning Commission, *Agriculture Plans and Programs for 1982/83* (Kathmandu: NPC, 1982); and Nepal, Ministry of Finance, *Economic Survey*, various issues (Kathmandu: MOF, various years).

[a] The agricultural sector comprises agriculture, irrigation, forestry, land reform, and cadastral survey.

---

[23] Peter A. Oram and Vishva Bindlish, *Resource Allocations to National Agricultural Research: Trends in the 1970s* (The Hague and Washington, D.C.: International Service for National Agricultural Research/International Food Policy Research Institute, 1981).

[24] World Bank, *Agricultural Research Sector Policy Paper* (Washington, D.C.: World Bank, 1981).

Budgetary Procedure

Budget expenditure in Nepal is classified under 12 major items, with some subitems (see Appendix 1, Table 47). The budget allocation is not based on the research projects. According to a treasury rule introduced in 1981, funds are released every four months through the District Treasury and Controller Office (DTCO). Financial control is strictly enforced in terms of total expenditure vis-à-vis total budget and of the expenditure under different items. Authority for transferring the budgeted expenditure from one item to another, as well as from one development activity to another, lies ultimately with the Ministry of Finance. The internal auditor of DTCO must audit the expenditure of the first four months (first installment) before the money is released for the second installment. From 1970/71 to 1980/81, the average annual released money for expenditure on agricultural research was only 71 percent of the planned allocated annual budget. The inflexibility in transferring funds and a long transfer process discourage researchers from undertaking any research into a problem that may have been identified in the current year.

The above analysis indicates that, despite the high priority given the agricultural sector in previous five-year plans, the financial allocation to the agriculture component of the sector is relatively low. Government priorities for agricultural research are apparent in the inadequate resources being invested in the national agricultural research system. Sixty-five percent of the budgeted agriculture research expenditure is spent to provide support services to production, leaving only 35 percent for actual research.

Trained Agricultural Personnel

Between 1970/71 and 1979/80, the trained personnel in agriculture increased by almost 2.5 times. In 1970/71, the total number of trained personnel was 1,397,[25] of which 352 employees were at the high level (officer rank) and 1,045 at the low level (junior technicians and junior technical assistants or their equivalents). The minimum training requirement for an officer-rank employee is an undergraduate degree in agriculture or the equivalent. In 1979/80 the total number of trained personnel in agriculture was 3,383, of which 873 employees were at the high level and 2,510 at the low level. Further breakdown of trained personnel in 1979/80, by department, is presented in Table 19. About 95 percent of the total trained personnel were

Table 19—Total trained agricultural personnel, 1979/80

Organization	High Level[a]	Low Level[b]	Total
Within the Ministry of Agriculture			
Ministry Secretariat	22	0	22
Department of Agriculture	442	1,761	2,203
Department of Livestock and Animal Health	108	268	376
Department of Food and Agricultural Marketing Services	53	0	53
Corporations	148	421	569
Subtotal	773	2,450	3,223
Outside the Ministry of Agriculture	100	60	160
Total	873	2,510	3,383

Source: Nepal, Agricultural Projects Services Center, *Trained Manpower for the Agricultural Sector,* vols. 1 and 2, (Kathmandu: APROSC, July 1981).

[a] Class 1, 2, and 3 officers. A graduate in agriculture begins work as a Class 3 officer.

[b] Junior technicians and junior technical assistants.

---

[25] Nepal, Ministry of Agriculture, *Ten-Year Agriculture Plan* (Kathmandu: MOA, 1972).

employed in the Ministry of Agriculture and its allied institutions. The Department of Agriculture alone employed 65 percent of the total trained personnel. The agricultural institutions, namely, the Agriculture Inputs Corporation, Agriculture Development Bank, and Agricultural Projects Services Centre, are semiautonomous agencies. Outside the Ministry of Agriculture, the largest employer was the Institute of Agriculture and Animal Science under Tribhuvan University.

The number of trained personnel in agricultural research, agricultural extension, and agricultural education in 1979/80 is given in Table 20, which indicates that 44 percent of high-level trained personnel were engaged in agricultural research, 21 percent in extension, and 8 percent in education. Of low-level personnel, 59 percent were employed in extension service and 23 percent in agricultural research. Though a large proportion of high-level trained personnel was employed in agricultural research, the work of those employees was related more to extension than to research. (This was explained in the earlier discussion of budget and time allocation of researchers.)

The number of trained personnel working in various fields of agricultural research in 1979/80 is shown in Table 21. At that time, there were 104 Class 1 and Class 2 officers and 284 Class 3 officers. Employees of officer rank are divided into special, first, second, and third classes. A graduate in agriculture begins his career as a Class 3 officer.

Crops, livestock, and horticulture accounted for about 75 percent of the total research staff and 82 percent of the total budgeted research expenditure (Tables 16 and 21). The greatest concentration of research personnel was in crop research, which accounted for about 41 percent of the officer-level researchers and 38 percent of the total research expenditure, followed by livestock with 17 percent of researchers and 24 percent of research expenditure, and horticulture with 17 percent of researchers and 20 percent of research expenditure.

The data in Table 21 also include researchers who did not have undergraduate degrees in agriculture but were promoted to officer level on the basis of seniority. On average, there were 1.5 research assistants per research worker.

A 1983 survey by the author of personnel in agriculture indicated that there were 1,052 employees with baccalaureate or higher degrees, of whom 34 had Ph.D.'s, 414 had master's degrees, and the remaining 604 had B.S. degrees. Within the Ministry of Agriculture and its parastatals, there were 964 degreed personnel, of whom 29 had Ph.D.'s, 351 had M.S.'s, and the remaining 584 had B.S. degrees (see Appendix 1, Tables 48 and 49). Agricultural economics dominated all other disciplines in the number of employees with Ph.D. and M.S. degrees (Appendix 1, Table 49). The majority of these officials worked at the Agricultural Projects Services Centre.

In all, about 400 trained high-level personnel worked in agricultural research; almost half of them had postgraduate degrees. Of the 14 Ph.D.'s, 10 held administrative posts. Since an administrative post, such as chief of a section or department, is more lucrative and higher in status, personnel with Ph.D.'s will seek these positions. As their numbers increase, however, most of them will probably be employed full time in conducting research. The Ph.D. component now constitutes only 4 percent of the personnel in agricultural research—well below the target of 20 percent suggested by the World Bank.[26] The weakness in the national research system for conceptualizing, planning, and directing research may be due partly to such a low percentage of Ph.D.'s in the system. A breakdown by discipline shows that the plant sciences have 60 percent of research staff who hold B.S. degrees and above, while livestock has only 15 percent of the total research staff (see Table 22).

Training

The Institute of Agriculture and Animal Science is the only institute that offers middle- and high-level training in agriculture. All training for junior technicians and junior

---

[26] World Bank, *Agricultural Research Sector Policy Paper.*

Table 20—Trained personnel in agricultural research, extension, and education, 1979/80

Category	High Level[a]	Percentage of High Level	Low Level[b]	Percentage of Low Level	Total	Percentage of Total
Agricultural research	388	44	586	23	974	29
Agricultural extension	184	21	1,480	59	1,664	49
Agricultural education[c]	73	8	4	. . .	77	2
Total	645	73[d]	2,070	82[d]	2,715	80[d]

Source: Unpublished data collected by the Agricultural Projects Services Center, Nepal, for a study of trained personnel in the agricultural sector.

[a] Class 1, 2, and 3 officers. A graduate in agriculture begins work as a Class 3 officer.

[b] Junior technicians and junior technical assistants.

[c] Institute of Agriculture and Animal Science.

[d] Twenty-seven percent of high-level and 18 percent of low-level trained agricultural personnel are otherwise employed in such organizations as the Agricultural Development Bank and the Department of Irrigation, Hydrology, and Meteorology and as administrators in the Ministry of Agriculture.

Table 21—Trained personnel in agricultural research, by rank and research category, 1979/80

Research Category	High Level[a]			Low Level[b]	Total
	Classes 1 and 2	Class 3	Subtotal		
Crop[c]	45	114	159	202	361
Livestock	20	46	66	148	214
Horticulture	17	49	66	99	165
Fisheries	6	24	30	55	85
Food science and nutrition	5	15	20	20	40
Input	8	24	32	37	69
Socioeconomic	3	12	15	25	40
Total	104	284	388	586	974

Source: Unpublished data collected by the Agricultural Projects Services Center, Nepal, for a study of trained personnel in the agricultural sector.

[a] A graduate in agriculture begins work as a Class 3 officer.

[b] Junior technicians and junior technical assistants.

[c] Includes the research staff of disciplinary sections, such as entomology, plant pathology, soil science, agricultural botany, and agricultural engineering.

Table 22—Trained officers in agricultural research, by education and discipline, 1979/80

Subject	Ph.D.	M.S.	B.S. or Equivalent	Total
Agronomy	2	20	55	77
Botany	3	10	10	23
Horticulture	1	18	40	59
Plant pathology	1	14	21	36
Entomology	1	13	7	21
Soil science	0	13	7	20
Fisheries	0	14	8	22
Agricultural engineering	0	5	22	27
Agricultural economics	3	22	0	25
Livestock and veterinary science	1	12	47	60
Food science and nutrition	2	16	0	18
Total	14	157	217	388

Source: Unpublished data collected by the Agricultural Projects Services Center, Nepal, for a study of trained personnel in the agricultural sector.

technical assistants is conducted within Nepal. The institute started a program for a B.S. degree in agriculture in 1977 and graduated the first group of students in 1979. The present enrollment capacity for undergraduate training is about 100. All graduate training (M.S. and Ph.D.), except in the social sciences, takes place in foreign countries.

The institute's staff comprises 5 Ph.D.'s, 53 M.S.'s, and 20 B.S.'s. The real expenditure of the institute increased at the rate of only 1.8 percent annually between 1972/73 and 1980/81. During this period, the average real annual expenditure was only Rs 1.6 million. Thus the training component of agriculture, like research, suffers from a shortage of financial resources and Ph.D. staff. Both research and training have received low priority, even though they play a significant role in the development of agriculture.

6

RESEARCH MANAGEMENT AND INCENTIVES

Motivation of researchers is the key to productive agricultural research. The strengthening of agricultural research systems is often thought of in terms of training, building research laboratories, and other physical facilities, without regard for the human element, which is the key to performance. The essence of good management is to keep employees interested and motivated in their work. This can be brought about through a reward system based on work performance.

Researchers in Nepal are performing much below their capacity. Interviews with a selected group of them have highlighted some problems and issues related to management and incentives in agricultural research.

Researchers' Opinions of Management and Incentives

In Nepal, government employees are classified into two broad categories, gazetted and nongazetted. Employees of the officer rank fall under the gazetted category. Gazetted officers are further grouped into four classes: special, first, second, and third. Graduates in agriculture begin their careers as Class 3 officers. Technical professionals are rarely promoted to the special class, since it is restricted to the general administrative cadre. Permanent government secretaries are considered special class employees.

A total of 120 researchers from different disciplines and geographical regions were interviewed. There were 10 Class 1, 24 Class 2, and 86 Class 3 officials. About 10 percent were women. In terms of academic qualifications, there were three Ph.D.'s, 52 M.S.'s, and 60 B.S.'s (agriculture) or the equivalent. Promotion between classes takes many years. All Class 1 officials had served more than 20 years. Six Class 2 officials had served for more than 20 years, 17 for between 11 and 20 years, and only one for less than 10 years. In Class 3, 6 had served more than 20 years, 33 from 11 to 20 years, 13 from 6 to 10 years, and 34 for less than 5 years (see Table 23).

Table 23 also shows a high frequency of personnel transfer in research work. Fifteen officials of Classes 1 and 2 had been transferred more than three times, 5 were transferred three times, and 9, two times. Thirty-four of the 86 Class 3 officials had been transferred two or more times.

Table 23—Classification of 120 research officers by sex, education, and number of years and transfers in service

Category	Officer Class[a] 1	2	3	Total
	(number of researchers)			
Sex				
Male	10	19	78	107
Female	0	5	8	13
Education				
High school	0	1	4	5
B.S.	2	4	54	60
M.S.	6	18	28	52
Ph.D.	2	1	0	3
Outside training[b]	5	15	23	43
Years in service				
0–5	0	0	34	34
6–10	0	1	13	14
11–20	0	17	33	50
More than 20	10	6	6	22
Transfers in service				
0	0	0	30	30
1	0	5	22	27
2	3	6	18	27
3	2	3	9	14
More than 3	5	10	7	22

Source: Interviews with 120 agricultural researchers in Nepal.

[a] Graduates in agriculture begin their careers as Class 3 officers.

[b] Nondegree education, such as a participant training program, for periods of 1–12 months.

When researchers were asked for their opinions of existing promotional rules, only 25 percent were satisfied (see Table 24). In another study, 61.5 percent of 307 officers surveyed disliked the present pattern of promotion because of defective evaluation systems and frequent rule changes.[27] A longtime resident adviser on agricultural research in Nepal, Dr. Wayne Freeman, made the following comment on the promotion system:

> The system of promotion with the Department of Agriculture is slow and cumbersome. . . . The promotion system lacks objectivity and is subject to pressures and manipulation. "Fighting for promotion" is not an idle expression, but is literally, if not physically, true.[28]

Table 24—Researchers' opinions of promotion rules

Opinion	Officer Class 1	2	3	Total
	(number of researchers)			
Satisfactory	1	8	21	30
Unsatisfactory	9	14	56	79
No opinion	0	2	9	11

Source: Interviews with 120 agricultural researchers in Nepal.

The majority of the researchers interviewed said that their authority, accountability, flexibility, status, and salary were inadequate. Almost everyone favored higher levels in those areas but claimed that their responsibilities were already high (see Table 25). It is important to note that although the responsibility given to researchers is high, their accountability is relatively low, which implies some lack of concern about completing assigned work. Similar results were found in another study, which inferred that "job performance at present is unsatisfactory and is suffering from lack of adequate authority, accountability, status, and salary."[29]

About 64 percent of the researchers spent 50 percent or less of their time in research. Only 9 percent of the researchers spent all their time on research. Seventy percent spent time in administration, extension work, or both, and 54 percent felt that their time was not properly allocated. Consequently, 83 percent indicated that their time should be geared more to research (see Tables 26, 27, and 28).

Table 25—Researchers' ratings of job-satisfaction criteria

Criterion	Present Self-Rating High	Present Self-Rating Moderate	Present Self-Rating Low	Preferred Self-Rating High	Preferred Self-Rating Moderate	Preferred Self-Rating Low
	(percentage of researchers)					
Authority	6	37	57	69	31	0
Responsibility	54	40	6	86	14	0
Accountability	25	36	39	54	36	10
Status	10	43	47	70	30	0
Flexibility	10	36	54	55	40	5
Salary	2	13	85	81	17	2

Source: Interviews with 120 agricultural researchers in Nepal.

---

[27] T. B. Shrestha, *Job Environment and Job Consciousness of Agricultural Graduates Under the Ministry of Food, Agriculture and Irrigation (1978-79)* (Kathmandu: Agricultural Projects Services Center, 1980), p. 2.
[28] U.S. Agency for International Development, *Nepal Integrated Cereals Project Evaluation Report* (Kathmandu: USAID, 1983), p. 60.
[29] Shrestha, *Job Environment and Job Consciousness*, p. 6.

Table 26—Amount of researchers' time spent on research

Time Spent on Research	Officer Class 1	2	3	Total
(percent)	(number of researchers)			
100	0	0	11	11
75	2	7	23	32
50	0	2	25	27
Less than 50	8	15	27	50

Source: Interviews with 120 agricultural researchers in Nepal.

Table 27—Researchers engaged in nonresearch work

Type of Work	Officer Class 1	2	3	Total
	(number of researchers)			
None	0	0	11	11
Administration	4	6	7	17
Extension	0	2	36	38
Administration and extension	6	13	10	29
Other	0	3	22	25

Source: Interviews with 120 agricultural researchers in Nepal.

Table 28—Researchers' opinions of allocation of work time

Allocation of Time	Officer Class 1	2	3	Total
	(number of researchers)			
Present time is properly allocated				
Yes	2	8	45	55
No	8	16	41	65
More time should be devoted to research				
Yes	9	20	71	100
No	1	4	15	20

Source: Interviews with 120 agricultural researchers in Nepal.

Only 66 percent of the researchers were employed in their preferred profession. Twenty-eight percent accepted jobs in agricultural research because of a lack of alternatives, and about 40 percent preferred other jobs at the time of the study interview. About 68 percent had not published a research report in the last five years (1976-81). Since the research papers published from research project assignments are not considered in promotions, there is no motivation to publish or write research monographs. Only 20 percent of the researchers had written two or more research reports in the last five years. About 17 percent of the researchers had not had a research project during that period, and 18 percent had done only one research project. Only a few were initiated as a result of the researchers' own interest (see Tables 29 through 32).

Research Constraints

Researchers were asked to rank the following research constraints: financial, research equipment, physical facilities (vehicles, laboratories, space, libraries, etc.), supporting staff, inadequate staff, lack of guidance and supervision, and lack of clear research policies and programs.

The three highest rankings were considered for analysis. The first was weighted the highest by assigning it three points; the second was assigned two points; and the third, one point. The points were aggregated in each category. It was found that inade-

Table 29—Researchers' reasons for accepting present positions

Reason	Officer Class 1	2	3	Total
	(number of researchers)			
Own interest	6	18	55	79
No alternatives available	3	5	25	33
Other	1	1	6	8

Source: Interviews with 120 agricultural researchers in Nepal.

Table 30—Researchers' preferences for different positions

Prefer Different Position	Officer Class 1	2	3	Total
	(number of researchers)			
Yes	5	8	35	48
No	5	16	51	72

Source: Interviews with 120 agricultural researchers in Nepal.

Table 31—Number of researchers' projects and publications, 1976-81

Number of Projects and Publications	Officer Class 1	2	3	Total
	(number of researchers)			
Research projects				
0	3	2	15	20
1	2	8	12	22
2	0	6	22	28
3	3	4	7	14
More than 3	2	4	30	36
Publications				
0	5	12	64	81
1	3	6	6	15
2	0	2	8	10
3	0	1	4	5
More than 3	2	3	4	9

Source: Interviews with 120 agricultural researchers in Nepal.

Table 32—Initiators of researchers' current experiments

Initiator	Officer Class 1	2	3	Total
	(number of researchers)			
Self	1	5	10	16
Colleagues	4	5	13	22
Chief	1	5	30	36
Self and chief	0	3	11	14
Colleagues and chief	0	0	9	9
No reply	4	6	13	23

Source: Interviews with 120 agricultural researchers in Nepal.

quate physical facilities and lack of clear research policies and programs were considered the most important constraints to research. A shortage of research equipment and a lack of budgetary support ranked third and fourth, respectively (see Table 33). It is interesting to note that researchers did not consider the lack of supporting staff or inadequate staff as a major constraint despite the fact that these are pointed to in many external evaluations of research.

As in most developing countries, the real problems are lack of clear research policies and programs, and ineffective utilization of manpower, both of which could be corrected internally without depending upon external aid. Most researchers in Nepal are juniors who hold only undergraduate degrees and need good supervision or guidance, but about 46 percent of them said that they did not receive this in their work. Only 30 percent of Class 3 officers, who have the greatest need for guidance, indicated that they received good or excellent supervision (see Table 34). Inadequate guidance, supervision, and monitoring seem to be serious impediments in the present system.

Agricultural research is presently carried out under government departments in Nepal. In many Asian countries, research is organized under an autonomous institution such as an agricultural research council. About 88 percent of the researchers surveyed, including 94 percent of Class 1 and 2 officers, wanted research to be reorganized under such a council (see Table 35).

Motivation and Efficiency

Researchers identified the following additional factors that have adversely affected their motivation and efficiency. Low salaries are regarded as a serious problem by most of the researchers. Almost everyone suggested an increase in salaries and other allowances. The real salary and allowance of all government officers declined by 20 to 25 percent between 1970/71 and 1980/81. The decline was about 40 percent for Class 1 and 2 officers between 1962/63 and 1980/81.[30]

---

[30] Nepal, *Pay Commission Report* (Kathmandu: Government Press, 1983).

Table 33—Researchers' ranking of constraints to research

Constraints	Researchers' Ranking I	II	III	Total Score[a]
	(number of researchers)			
Financial	23	18	18	123
Research equipment	19	25	21	128
Physical facilities	30	19	21	149
Supporting staff	10	18	21	87
Inadequate staff	18	10	17	91
Lack of guidance and supervision	8	24	10	82
Lack of clear research policy and program	33	14	15	142

Source: Interviews with 120 agricultural researchers in Nepal.

[a] Total score was computed on the basis of values assigned: Rank I = 3, Rank II = 2, Rank III = 1.

Table 34—Researchers' rating of research guidance from supervisor

Rating	Officer Class 1	2	3	Total
	(number of researchers)			
Excellent	1	2	8	11
Good	7	5	18	30
Fair	0	5	18	23
Poor	0	3	12	15
No proper supervision	2	9	30	41

Source: Interviews with 120 agricultural researchers in Nepal.

Table 35—Researchers' preferred organization of research bodies

Existing Research Organization	Officer Class 1	2	3	Total
	(number of researchers)			
Stay as is, with government	1	1	12	14
Reorganize into autonomous institution	9	23	74	106

Source: Interviews with 120 agricultural researchers in Nepal.

Because of a lack of job descriptions and poor definition of responsibilities, researchers work mostly on verbal instruction from their supervisors. Frequent changes in their assigned tasks result in low motivation and an atmosphere that is not conducive to serious research.

Researchers complained that their work is not evaluated regularly and objectively. The current practice of evaluation of researchers by their supervisors to meet the requirements of the Public Service Commission regarding promotion does not reflect their actual performance (this problem is discussed in the following section on promotion rules). Researchers stated that an objective and impartial evaluation, if done regularly, would motivate them to work harder. The present system of evaluation has only encouraged inefficiency and incompetency.

Senior researchers and sectional chiefs said that they cannot make purchases of small items or materials needed for their research without the approval of higher authority. Sometimes they must delay their work while their request for action goes through the cumbersome process of approval. They indicated that the delegation of some financial and administrative authority to them would greatly improve their performance.

Almost all researchers (92 percent) expressed the need for a high-level college degree or short-term specialized training, or both, as prerequisites to becoming effective researchers (see Table 36). Fifty-five

Table 36—Researchers' desire for further training

Type of Training	Officer Class 1	2	3	Total
	(number of researchers)			
None	2	2	4	8
Higher degree	4	14	41	59
Short-term training	3	3	26	32
Higher degree and short-term training	0	4	15	19
Other[a]	1	1	0	2

Source: Interviews with 120 agricultural researchers in Nepal.

[a] Training such as a study tour of 2–4 weeks.

percent of the researchers have only a B.S. in agriculture or the equivalent. The common feeling among researchers was that the minimum level of training for a research worker should be an M.S. Only at the M.S. level of training does a person learn research methodology and statistical analysis and carry out a research project independently. There was also concern about the acute shortage of researchers with Ph.D. training to provide leadership and guidance in research. Presently there are only 14 Ph.D.'s in the entire research system, and most of them occupy administrative positions. Ruttan points out that

> At the beginning, when only limited professional capacity is available, there is a tendency for research staff to move from research into administrative and policy positions after a short research or teaching career. The capacity to provide a continuous stream of replacements is essential to the continued viability of the research efforts.[31]

The interviews also showed that junior researchers do not receive adequate guidance and supervision in their work from senior researchers.

The lack of research publication facilities is a serious constraint in promoting agricultural research in Nepal and has received little attention at the higher levels of administration. A large quantity of data has been generated by the researchers but retained only in files that are destroyed after a few years. Lack of financial support for the publication of the Nepal Journal of Agriculture and other scientific journals, and nonrecognition for promotion purposes of publications resulting from assigned research have led to this dismal situation. Researchers view publication of their research work as an important factor in boosting their work and confidence.

The research staff who work in the system on a temporary basis for a year or more were found to have the lowest level of morale or motivation. They are neither certain to continue in the field of research where they are currently employed nor eligible for any training opportunities or long-term employment benefits. The cumbersome and long process of creating permanent posts in the government and recruiting staff through the Public Service Commission delays the appointment of permanent staff. Even when they are recruited, their individual research interests are not taken into consideration.

Most researchers expressed dissatisfaction with the current promotion rules and long delays in promotion (Tables 23 and 24). They expressed serious doubts about prospects for any improvement in the current rules and for their timely promotion under the present structure. They indicated that only autonomous research institutes would be able to formulate and execute personnel policies designed to meet research requirements.

Almost all the technical sections, research stations, and farms have ill-equipped library facilities. Most of the researchers expressed the need for good library facilities to assist them in their research work and publications. Presently, research stations receive only Rs 1,000 annually for the purchase of books, journals, and newspapers.

The role of leadership in promoting any organization is extremely important. Researchers expressed a need for administrators who have vision and who could provide intellectual leadership in shaping the overall research program. Researchers strongly urged that such a person be identified and appointed to lead the research system.

Promotion Rules

Existing promotion rules contain some serious problems that hamper research. Four factors are considered in evaluating a researcher in Nepal. They are length of service; education, training, and research publication; work performance and capability; and experience. The evaluation methods are designed objectively, using numbers for each factor. A gazetted officer in the government is eligible for promotion after five years of service in a particular class. For every year of service an officer receives eight points.

---

[31] Vernon W. Ruttan, *Agricultural Research Policy* (Minneapolis: University of Minnesota Press, 1982), p. 177.

The evaluation of education is done from high school through the Ph.D. For each certificate, diploma, or degree, the points given for graduating in the first, second, or third division are 24, 20, and 16, respectively. A Ph.D. degree is always assigned 24 points. For in-service or foreign training exceeding a month, an officer receives a maximum of 10 points. For a research publication, a maximum of 10 points is given. However, it is important to note that researchers cannot claim points for publications resulting from assigned work. This seems unreasonable because a researcher should be evaluated on the basis of his research output, which is usually a research report. The failure to assign credit for such publications may be one of the reasons researchers in Nepal are not motivated to publish the findings of their research.

Work performance and capability evaluations are done by supervisors. An evaluation requires two separate forms; one to evaluate the work performed by the individual every six months and the other to evaluate an individual's capabilities and other attributes annually. The maximum number of points allocated for each form is 60. The supervisor generally gives 48 or less points because if he gives more than 48 points he is required to justify the excellence of the employee's work, and this must be agreed to by the reviewer, a senior person, and finally approved by the chief secretary of the government. Also, the evaluated individual is required to give his or her consent to the evaluation score. To avoid creating tension among his subordinates, the supervisor usually gives everyone a total at or around 96 points.

The scoring of experience is based on the location of the employee in the country, which is divided into five geographical regions according to the difficulties caused by the physical terrain and the unavailability of services and amenities. In the most difficult region, an employee gets eight points for every year of service. In the least difficult region, only one point is given for every year of service. The middle three regions are assigned six, four, and two points, according to their ranking. The maximum number of points an officer can earn throughout a career is 40, and it is this restriction that causes researchers to feel the promotion rules are heavily stacked against them. Most of the research stations and laboratories are located in the least difficult region. Also, specialized research work does not permit transfers of researchers to different places, unlike administrative or extension work. Better ways could be found to compensate employees for working in difficult areas; for instance, monetary compensation would be more appropriate than points.

The current promotion rules have been designed primarily for employees of the General Civil Service and are inappropriate for researchers. Promotion rules for researchers need to be designed with the field of research in mind. This is possible only if a research organization separates itself from the general administration of the government, thus gaining control over the design of its personnel policies, recruitment, and promotion system. This autonomy is extremely important for the success of the research system.

Job Security

Government employees feel secure in their jobs. Shrestha found that only about 12 percent of the respondents complained about being insecure in their jobs.[32] A permanent employee being dismissed because of poor performance on the job is unheard of. The worst penalty imposed is transfer to difficult geographical areas. If an employee has links with a power group in the government, such a transfer can easily be nullified.

Publication

Publication of research articles universally provides both recognition and personal satisfaction to researchers. Researchers' performances are generally evaluated by the quality and quantity of their publications in research journals, so publication is an extremely important activity in a research system. In Nepal, this activity is seriously limited. There are currently three journals in which agricultural scientists can publish their research work. They are the *Nepalese Journal of Agriculture, Animal Health Bulletin,* and *Journal of the Institute of Agriculture and Animal Science.*

---

[32] Shrestha, *Job Environment and Job Consciousness,* p. 3.

Publication of the *Nepalese Journal of Agriculture* was begun in February 1966 by the Nepal Agriculture Association. Most of the agricultural graduates are the members of the association and pay a nominal annual membership fee. The money collected is used to pay a part of the publication cost of the journal. The association published the journal regularly for five years, stopped publication from 1971 to 1975, and again published in 1976, 1977, and 1979, after which publication was again discontinued until 1986. Thus, in the 1970s, both the Nepal Agriculture Association and the publication of the *Journal of Agriculture* were almost dormant. The association was inactive because of lack of interest among its members, and the government provided no financial support for the publication of the journal. The Nepalese Council of Science and Technology, an independent organization that promotes scientific work throughout Nepal, awarded Rs 5,000 to the *Nepalese Journal of Agriculture* in 1977 for being an outstanding scientific journal. This indicates the potential for such a journal, but lack of funds precludes its regular publication.

The Nepal Veterinary Association began annual publication of the *Animal Health Bulletin* in 1977. This association is relatively more active than the Nepal Agriculture Association but faces similar financial constraints in publishing its bulletin regularly.

The Institute of Agriculture and Animal Science began publishing its journal in December 1977. The institute finances the publication of the journal and publishes it annually.

A total of 94 articles have been published in the *Nepalese Journal of Agriculture,* 23 in the *Journal of the Institute of Agriculture and Animal Science,* and 30 in the *Animal Health Bulletin.* The lack of support for the publication of journals demonstrates the low priority accorded to research in Nepal.

Staff Instability

Staff instability is not a serious problem in Nepal, since there are few job opportunities for agricultural technicians outside the public sector. Also, the Public Service Commission discourages movement of staff from one discipline to another. However, the instability of agricultural economists is high compared to other disciplines because job opportunities for agricultural economists are greater than for other agricultural disciplines.

Though staff instability does not seem to exist in terms of leaving the research institute, frequent transfer of staff is a serious problem. For instance, a serious manpower constraint is reported in the national rice development program because most of their trained personnel have been transferred to other posts and new staff must be recruited and trained.[33]

Instability at Policy and Managerial Levels

Frequent transfers of officials at the policy and managerial levels have also adversely affected the development of agriculture in Nepal. In a 16-year period (1967-83) there were 16 ministers of agriculture. Of the 16, 8 served less than a year and the remaining 8 served between one and two years. Similarly, in a 14-year period (January 1969 to October 1982) there were 9 permanent secretaries in the Ministry of Agriculture. Of the 9, 4 served less than one year; 2, between one and two years; and 3, between two and three years. As for directors general of agriculture, there were 4 in the nine years from 1972 to 1981. The positions of joint secretary for planning in the Ministry of Agriculture and director general of the Food and Marketing Services Department, which hold the main responsibility for agricultural planning and socioeconomic studies, both had 5 occupants within nine years. From the early 1970s to the early 1980s, the average period that the heads of the Agricultural Input Corporation, the Agricultural Development Bank, and the Agricultural Projects Services Center remained in their posts was two to three years. The deputy directors general of Agricultural Research remained in office for about four years.

---

[33] Nepal, Department of Agriculture, *The Integration of Research and Extension in Farmers' Fields: The Terminal Report of the Integrated Cereals Project* (Kathmandu: Ministry of Agriculture, 1985), pp. 54-55.

Research policies and priorities are determined in the Ministry of Agriculture; the deputy director general merely carries out those policies. Thus, during the 1970s, frequent changes in personnel at the helm caused great instability in agricultural policies and programs. The frequent juggling of senior positions subsequently brought changes to the lower level of administration as well.

Instability at policy planning and executive levels also leads to administrative inefficiency. An employee may feel secure as a government employee but be vulnerable in a particular position. Therefore, officials use their energy and talents in soliciting sociopolitical support to ensure their continuity in the current position and, if possible, for advancement to higher levels. In this process, these officials are more likely to yield to sociopolitical pressures. Freeman's observation is noted here:

> . . . [the] Department of Agriculture is subject to political pressures and changes in many ways. The Director General is frequently replaced and the policies and even the administrative structure of the department are subject to change. Within the Department of Agriculture those responsible for administering research are burdened with day-to-day problems and political pressures so that research management occupies only a small portion of their time.[34]

---

[34] U.S. Agency for International Development, *Integrated Cereals Project*, p. 59.

7

AGRICULTURAL RESEARCH PRIORITIES AND STRUCTURE: SOME CONCLUDING OBSERVATIONS

Agricultural development is an extremely complex process. It is the balanced combination of prices, technology, infrastructure, and institutions that promotes and sustains production growth. Although all these elements are important, the pivotal factor in modernizing traditional agriculture is improved agricultural technology, without which the effectiveness of other factors remains weak.

Although Nepal is a small country, it has considerable agroclimatic variation. In the mountains, for example, there are many microregions with differing conditions. A crop variety suitable for one microregion may not be suitable for another, and the transferability of agricultural research recommendations is limited.

Opportunities for borrowing and adapting research results from abroad may be particularly advantageous for rice, maize, wheat, sugarcane, and jute cultivation in the Tarai, which is part of a large agroclimatic subregion that receives substantial research attention from international and other national research institutes, but such opportunities are extremely limited for the hill and mountain regions. The development and management of agriculture and natural resources in the hills, where 56 percent of the population subsists on only 43 percent of the cultivated land, will depend much more on indigenous development of appropriate agricultural technology that is location-specific, but there is little relevant technology to draw on from other similar areas. Worldwide high-altitude agriculture is difficult and has been neglected.

Although the short-term returns on this type of research investment may not compare favorably with similar expenditures on research in more prosperous areas, the continued absence of appropriate research for the hill region is likely to result in adverse conditions for income distribution and in resource depletion of the country as a whole. Agricultural production and productivity have deteriorated much faster in the hills than in the Tarai. The food, fuel, and fodder requirements of the large and increasing human and livestock populations are leading directly to serious depletion of natural resources and to erosion through forest degradation, overgrazing, and cultivation on steep slopes. This erosion causes siltation and flooding problems in the Tarai and beyond Nepal's borders. To prevent ecological degradation, the specific areas for research would be agroforestry, forage and fodder, terracing, erosion control, soil fertility, and genetic improvements of indigenous varieties. To promote commercialization of agriculture, research on mountain infrastructure (transport), storage, agricultural marketing for inputs and outputs, and subsistence versus cash crops is crucial. When looked at in the longer term, the potential returns on investments in appropriate hill region research are substantial.

Agricultural research priorities and strategies should generally follow the overall strategy of agricultural development in Nepal. The long-term development strategies of agriculture are correctly identified in the Fifth Five-Year Plan on the basis of comparative advantages in regional specialization, whereby the predominant economic activities would be horticulture and livestock production in the hills and mountains and foodgrain production in the Tarai.

The absence of a systematic program to carry out long-term national research strategies and priorities in accordance with regional specialization has led to various ad hoc agricultural research programs in which there is no direction and allocated resources are not used for actual research purposes. The potential returns on a carefully planned research program and on investments are considerable.

The food balance report of the Food and Agricultural Marketing Services Department indicates that 28 of the 55 hill districts had food deficits in 1974/75, 38 had deficits in 1978/79, and 47 in 1982. In the long run the Nepalese hills are unlikely to be self-sufficient in foodgrain because of a continuous decline in agricultural productivity that is exacerbated by a diminishing scope for expanding cultivated areas and by the increasing population in the hills. It should also be recognized that the hills contain a large upland region devoid of irrigation and with soil that is very low in plant nutrients. Approximately 80 percent of cultivated land in the hills is upland and more than 90 percent of the cultivated land is unirrigated. Therefore, dramatic increases in foodgrain production are unlikely. However, improving cereal production in the valleys and lowland is possible by raising crop yields, especially where yields are still at traditional levels.

Production technologies for rainfed upland agriculture are yet to be developed. A high level of investment in agricultural research pertaining to the diverse conditions of the hill area will be needed to develop agricultural technologies that will increase yield and improve soil conservation and management. Agricultural research must be central to the design of development strategies for the hills.

Any significant boost in crop production in Nepal must come from the Tarai.[35] Here the potential for improving yields in foodgrains and cash crops through increased application of improved seeds, fertilizers, pesticides, irrigation, and water management is substantial. In the past, increases in Tarai foodgrain production have resulted almost entirely from increases in cropped areas. The scope for further increasing land under cultivation is extremely limited, since this would be possible only at the cost of reclaiming land from forestry. Thus an increase in foodgrain production must largely come from increasing productivity through promotion of irrigation, greater intensity of cropping, and development and dissemination of improved agricultural technology. A substantial investment will be needed to increase irrigation facilities, build agricultural research capabilities, and establish production support programs such as extension, input, credit supply, and marketing.

The following conceptual framework for complementarities in production between the hills and the Tarai is suggested. A higher production of foodgrain in the Tarai could generate a large marketable surplus. With proper infrastructural support, this surplus could benefit hill people in two ways. First, present constraints on wage goods that are essential for an employment-intensive program could be released. Low-income people spend the bulk of their additional income on food, and a high-employment policy increases the income of the poor, whose demand for food subsequently increases.[36] This increase in demand for food could be met from the marketable surplus generated in the Tarai. Second, the surplus would have an effect on the domestic prices of foodgrain, depending upon the quantities exported. It is commonly believed that benefits of technological innovations in the production of foodgrains for which the demand is inelastic are passed to consumers, particularly the urban population and hill people in the case of Nepal.

Conversely, the hills will produce fruits and vegetables, livestock products, and handicrafts, the demands for which are elastic. In the production of such commodities, the benefits of technological innovations are passed to the producers. Thus, technological innovations in foodgrain production in the Tarai will not only benefit Tarai producers through an increase in production but will also benefit the hill people, who are potential consumers and will benefit further from technological innovations in horticulture, livestock, and the cottage industries.

---

[35] International Fund for Agricultural Development, *Report of the Special Programming Mission to Nepal.*

[36] John W. Mellor, *The New Economics of Growth: A Strategy for India and the Developing World,* a Twentieth Century Fund Study (Ithaca and London: Cornell University Press, 1976).

The hills and mountains have a comparative advantage in the production of horticulture and livestock products. However, there is a serious lack of improved technology and marketing for both subsectors. Farmers will undertake horticultural and livestock activities on a commercial scale only if the marketing of their products is guaranteed. Both horticulture and livestock are of special significance to the poor and to small farmers in terms of employment and income, since they are more labor intensive than foodgrains, both on and off the farm.[37]

Because of the perishability of these commodities, rapid transportation is essential. Therefore, an intensive program of horticulture and livestock development should be initially concentrated in a few hill and mountain pockets that have access to a good transport network. This program could gradually expand to other regions as transport and marketing networks develop. Also, the intensity of research on horticulture and livestock is very low. To pursue more diversified high-value and low-volume agricultural products, as postulated by the government, would place high demands on the agricultural research system in the hills.[38] The prerequisite for realizing this strategy is the provision of access to markets. This access will require massive investments in the development of transport and marketing networks linking the hill economy with the Tarai and with foreign markets.

Thus the development of transportation, marketing networks, and research is essential to hill development. Regional specialization, Tarai-hill integration, and trade become pivotal in the long-term agricultural development strategy of Nepal. In planning policies, care should be taken that short-term imperatives do not run counter to the long-term development potential of Nepal. For instance, every year more hill districts are becoming food-deficit districts, and the immediate national concern has been to turn all efforts toward increasing food production in the hills, albeit without much success. These efforts have diverted attention and resources from the long-term potential of horticulture and livestock development to the short-term imperatives of foodgrain production in the hills. Horticulture and livestock have attracted little or no attention from the bilateral and multilateral agencies. Without a policy change in priorities toward research and development programs for these two subsectors, the current trends of agricultural expansion into marginal lands for foodgrain production, rapid rates of deforestation, and rising population are likely to have even more serious consequences for the environment.

The allocation pattern of research expenditures between the hills and the Tarai to a large extent reflects regional specialization. For example, from 1970/71 to 1980/81 the average annual research expenditure on crops in the Tarai was Rs 4.269 million compared to Rs 0.852 million in the hills, indicating a greater research effort on food crops in the Tarai than in the hills. But the average annual research expenditures on horticulture and livestock in the hills were Rs 3.665 and Rs 2.789 million, respectively, compared with Rs 0.790 and Rs 0.910 million in the Tarai. A similar pattern is reflected in the allocation of trained agricultural manpower in agricultural research. For example, in 1979/80, 95 officer-level technicians worked in crop research in the Tarai compared with only 20 in the hills, and 116 officer-level technicians worked in livestock and horticulture in the hills compared with 16 in the Tarai.

The agricultural resource allocation patterns and disciplinary orientation of the research stations and farms in different locations of the country indicate that efforts have been made to follow a broad research strategy in accordance with regional specialization. However, this strategy has not been operationally effective, largely because of the low priority given to research activities in the annual work programs of the research stations and farms. The major preoccupations of these stations and farms have been to propagate improved seeds, fruit plants, and breeds of animals and to provide training and other production support services. Research on livestock and horticulture in the hills and mountains has been almost nonexistent.

---

[37] International Fund for Agricultural Development, Special Programming Mission, proposal for IFAD assistance in National Horticultural and Livestock Research Project, 1979. Proposed project did not materialize.
[38] Ibid.

Besides horticulture and livestock, other areas of research that presently receive almost no attention are factor-oriented ones such as labor, water utilization, land terracing, and soil conservation techniques; forage crops and fodder trees essential to meet the shortage of feed for livestock; grain legumes and pulses, which constitute a significant portion of the national diet and could improve the soil nutrients through nitrogen fixation; and some minor cereal crops such as finger millet, barley, and buckwheat, which are important food crops for many poor and subsistence farmers in the hills. Since only 14 percent of the total cultivated land is irrigated, farming in Nepal is largely conducted under rainfed conditions; therefore, the major crop research program should be oriented toward rainfed agriculture.

Social science is also at a low ebb. The inclusion of social scientists in the research programs of different commodities and in farming system research is essential to developing a socially acceptable and economically viable technology. Research in the area of agricultural policies is also warranted.

Types of Research

Ruttan postulates three generalizations regarding the agricultural research system for small countries. These are relevant for Nepal. First, the research investment per hectare will have to be higher in a small system than in a large one in order to achieve an equal level of effectiveness. Second, the cost of developing productive farming systems for a small country with wide agroclimatic variation will be greater than for a small, more geographically homogeneous country. Third, a small country will have to depend on others—international agricultural research systems, research systems of large countries in the same region, multinational firms—for much of its agricultural technology. However, a small country needs to develop sufficient expertise in agricultural science to enable it to draw selectively from other national and international research systems.[39]

In accordance with the induced innovation theory, research efforts should generate technology that will ease out the resource constraint that is inhibiting output expansion.[40] In Nepal, land and capital are the constraints, so research should focus mainly on biological and chemical innovations.

Since the possibility of borrowing technology from neighboring countries and international agricultural research centers is greater for the Tarai than for the hills, Nepal would benefit by emphasizing adaptive research in the Tarai in order to test or verify the suitability of these technologies. At the same time, the government could emphasize both strategic and adaptive research in the hills to develop and modify agricultural technology suitable to the hill environment. The technology-borrowing capacity of the research system could be enhanced through active efforts to acquire current journals and other research reports, and to visit and collaborate with research systems in neighboring countries and at international agricultural research centers. Also, varietal, plant protection, and agronomical trials are needed as prime activities of Tarai agricultural research. On the other hand, the most important focus for hill research is the generation of new technology, which would require an increased number of qualified plant and animal breeders as well as improved laboratory facilities.

---

[39] Vernon W. Ruttan, *Agricultural Research Policy*, pp. 177-178.
[40] Ibid.

The development of a viable, sustainable, and dynamic research system is a vital step toward meeting the needs of the country, and the role of foreign assistance is crucial in building such a system. Foreign aid has already provided expertise in training research personnel and building physical infrastructure in some specific components of agricultural research, but the research system as a whole is still weak, imbalanced, and underdeveloped and needs a holistic approach.

Ruttan points out that a national system designed to transfer, screen, and adapt technology requires essentially the same skills as a system devoted to the invention of new technology.[41] Therefore, advanced training should always receive high priority in building a research system that can carry both adaptive and strategic research.

Research Structure

It is evident from the earlier discussion that the Nepalese agricultural research system is poorly funded, organized, and managed. Although agricultural research is central to the success of any production support program, it has generally received lower priority than the production program. Donor assistance is readily available for the production program but not for research because research results require a long gestation period, and both donors and recipient governments want quick results or returns on their investment. Unless there is a favorable change in attitude toward research at the policy level and among donors, no substantive reform or investment can take place in research.

To substantially reform the system, the foremost prerequisite is a political will to accord high priority to agricultural research and to unify all agricultural research activities under one body. Under the present organizational structure, extension and other production support activities tend to dominate the overall program and research consequently suffers.

The experience of several other Asian countries indicates that an autonomous research organization is generally better equipped to provide an atmosphere for the necessary coordination of planning and logistical support, including attractive conditions of employment, than a research organization under government bureaucracy. An autonomous research organization can institute its own rules and regulations for staff recruitment and promotion and thereby create a better research environment. It should also have a monitoring and evaluation unit to administer the progress of research work and examine its relevancy and effectiveness.

There is some concern that reorganizing research under a separate autonomous body is likely to weaken the linkage between research and extension. However, having these two activities under the Department of Agriculture does not guarantee close coordination between them. The important consideration is that the objectives of agricultural research should be explicit, so that the research priorities and programs are related to the problems of farmers and their resources. The research system should be held accountable for its output and for the relevancy of that output. The program should be strictly monitored and evaluated so that the total research system focuses on the farmers' problems. In the past, several studies have emphasized the need for reorganization of agricultural research into a unified and autonomous structure.[42] The

---

[41] Ibid., p. 175.

[42] Ram P. Yadav, "Institutional Arrangements for Agricultural Research in Nepal," in *Research, Productivity and Mechanization in Nepalese Agriculture,* ed. Bhavani Dhungana, a seminar report (Kathmandu: Center for Economic Development and Administration, Tribhuvan University, 1976); Nepal, Department of Agriculture, *A Proposal for Organizing Agricultural Research in Nepal,* Mid-term Preliminary Draft, April 7-May 27, 1977; ADB/Nepal, *Nepal Agricultural Sector;* FAO/World Bank Cooperative Program, *Nepal Agricultural Research Review Mission Report* (Rome: FAO, 1984); USAID, *Nepal Integrated Cereals Project Evaluation Report,* suggests a semiautonomous research and development institution that could provide a degree of freedom in personnel policy, fiscal policy, and research direction, and some insulation from political pressures; Report of the Joint Review Team, A Proposal for a Nepalese Council for Agricultural Research, March 1978; IFAD Programming Mission in 1979 supported the proposed National Council for Agricultural Research and recommended that IFAD support establishment of the council.

Ministry of Agriculture will have to play a coordinating role to effectively link research and extension.

The current decentralization plan of the government of Nepal requires that all sectoral development activities at the district level be coordinated and administered by the district development officer, and that technical support and guidance be provided through technical departments and ministries. Therefore, the agricultural extension program will have to be carried out by the Department of Agriculture through 5 regional agricultural directorates and 75 district agricultural development offices.

The Institute of Agriculture and Animal Science (IAAS) can play an important role in meeting the trained manpower needs for research and extension, especially if high priority is given to upgrading the training. Within 7 to 10 years the IAAS could be converted to an agricultural university and should maintain close contact with the proposed autonomous research organization through exchange of staff. Ultimately there could be complete amalgamation of the research organization into the agricultural university, bringing research and teaching together so that both research and training become mutually reinforcing and relevant.

APPENDIX 1: SUPPLEMENTARY TABLES

Table 37—Share of various sectors in development expenditures during five-year plans, 1965-85

Sector	Third Plan 1965-70	Fourth Plan 1970-75	Fifth Plan 1975-80	Proposed Sixth Plan 1980-85
		(percent)		
Agricultural[a]	17.56	21.72	25.43	30.34
Transportation and communications	31.29	41.15	27.68	19.45
Industry, mining, commerce, and electricity	10.03	14.54	18.74	25.75
Social services[b]	17.20	17.25	23.22	22.14
Others	23.92	5.34	4.93	2.32
Total development expenditure	100.00	100.00	100.00	100.00

Sources: Third and Fourth Plan data are based on World Bank, *Nepal: Development Performance and Prospects*, a World Bank Country Study (Washington, D.C.: World Bank, 1979); Fifth Plan data are from Nepal, Ministry of Finance, *Nepal: Economic Survey for FY 1980/81* (Kathmandu: MOF, 1981); and Sixth Plan data are from Nepal/World Bank, *Allocation of Development Expenditure in the Public Sector*, an economic memorandum on Nepal (Kathmandu: Ministry of Finance), Appendix E, p. 98.

[a] The agricultural sector comprises agriculture, irrigation, land reform, forestry, and cadastral survey.

[b] Social services include education, health, and drinking water.

Table 38—Total GDP, agricultural GDP, and budget expenditures, 1970/71-1980/81

Year	Total GDP	Agricultural GDP	Total Budget Expenditures	Total Development Expenditures	Total Agricultural Sector Expenditures
			(1972/73 Rs million)		
1970/71	11,266	7,605	866.0	523.3	106.6
1971/72	12,899	8,840	988.1	637.2	118.7
1972/73	11,165	7,637	982.6	608.6	120.3
1973/74	12,517	8,650	1,070.1	655.7	168.3
1974/75	12,366	8,534	1,129.7	721.8	154.6
1975/76	12,327	8,147	1,356.1	878.0	259.0
1976/77	12,212	7,342	1,646.9	1,058.9	272.5
1977/78	12,657	7,451	1,715.8	1,159.7	283.7
1978/79	13,790	8,296	1,874.9	1,228.3	332.3
1979/80	14,148	7,613	2,444.9	1,321.3	291.3
1980/81	13,631	7,701	2,031.9	1,356.1	336.1
			(percent)		
Annual growth rate	1.53	−0.57	10.67	10.89	13.56
t-statistic	3.20	−0.81	11.97	14.77	9.13

Sources: Unpublished data from National Planning Commission Secretariat and Central Bureau of Statistics, Nepal; and Nepal, Ministry of Finance, *Economic Survey*, various issues (Kathmandu: MOF, various years).

Table 39—High-yielding cereal varieties released in Nepal, 1959-85

Crop	Serial Number	Name of Variety	Origin	Year of Release	Recommended for Hill	Recommended for Tarai	Remarks[a]
Rice	1	CH-45	China	1960	x	x	Early, 1
	2	N-136	India	1962		x	0
	3	BR-34	India	1962		x	0
	4	BR-8	India	1962		x	0
	5	Taichung-176	Taiwan	1966	x		2
	6	Chainung-242	Taiwan	1966	x		3
	7	Kaoshung-24	Taiwan	1966	x		0
	8	Chainan-2	Taiwan	1966	x		0
	9	Tainan-1	Taiwan	1966	x	x	0
	10	Taichung Native-1	Taiwan	1967		x	3
	11	IR-8	IRRI	1968		x	0
	12	IR-5	IRRI	1969		x	0
	13	IR-20	IRRI	1970		x	0
	14	IR-22	IRRI	1972		x	0
	15	Khumal-1	Taiwan	1972	x		0
	16	Parwanipur-1	Taiwan	1973		x	3
	17	Jaya	India	1973		x	3
	18	Masuli (Mahsuri)	Malaysia	1973		x	1
	19	IR-24	IRRI	1975		x	0
	20	Chandina (IR532)	IRRI	1977		x	Early, 3
	21	Laxmi (IR2061)	IRRI	1979		x	Early, 2
	22	Durga (IET2938)	India	1979		x	3
	23	Sabitri (IR2071)	IRRI	1979		x	1
	24	Janaki (BG-90-2)	Sri Lanka	1981		x	1
	25	Bindeswari (IET1444)	India	1981		x	Early, 1
	26	Kanchan (IR3941)	IRRI	1982	x		1
	27	Himali (IR2298)	IRRI	1982	x		Early, 1
	28	Malika (Mala/J15)	Bangladesh	1982		x	2
	29	Khumal-3 (Ch1039XIR580)	India	1983	x		1
Maize	1	Amarillo de Cubano Flint	United States	1959	x	x	
	2	Khumal Yellow		1968	x		1
	3	Rampur Yellow		1968		x	2
	4	Kakani Yellow		1969	x		2
	5	Hetauda Composite	Nepal	1972	x	x	3
	6	Rampur Composite	Thailand	1975	x	x	1
	7	Sarlahi White	Philippines	1975		x	3
	8	Janaki Makai		1979		x	winter, 3
	9	Arun-2	UNCC XDHR	1981	x	x	1
	10	Makalu-2	(Amarillo del Bajio)	1984	x		1
Wheat	1	Lerma-52	CIMMYT	1960	x		2
	2	Petic-62	CIMMYT	1967	x		0
	3	Lerma Rojo-64	CIMMYT	1967	x		3
	4	S-331	India	1969		x	0
	5	S-227	India	1969		x	0
	6	RR-21 (Sonalika)	India	1971	x	x	1
	7	NL-30	India	1975		x	2
	8	HD-1982	India	1975		x	0
	9	UP-262	India	1979		x	1
	10	Lumbini	India	1981		x	2
	11	Siddhartha	India	1983		x	2
	12	Triveni	India	1983		x	2
	13	Vinayak	India	1983		x	2
	14	Vaskar	CIMMYT	1983		x	2
	15	Nepal 297		1985		x	

Sources: Nepal, Department of Agriculture, *The Integration of Research and Extension in Farmers' Fields: The Terminal Report of the Integrated Cereals Project* (Kathmandu: Ministry of Agriculture, 1985), p. 49; and Food and Agriculture Organization of the United Nations, *Seed Status Survey Report* (Rome: FAO, 1981).

[a] According to the FAO *Seed Status Survey Report*, the importance or popularity of varieties is categorized as follows: 1 = very important, 2 = important, 3 = less important, 0 = grown occasionally or not at all.

Table 40—Foreign-aided projects that partly support agricultural research activities in Nepal, 1982

Project	Financing Agency
Agricultural Research and Extension	International Development Association/World Bank (IDA/WB)
Cash Crop Development (sugarcane, tobacco, oilseed, ginger, sericulture)	IDA/WB
Narajani Zone Irrigation Development, Stage II	IDA/WB
Sunsari and Morang Irrigation and Drainage Development, Stage I	IDA/WB
Rasuwa-Nuwakot, Integrated Rural Development Project (IRD)	IDA/WB
Chitawan Irrigation Project	Asian Development Bank (ADB)
Kankai Irrigation Project	ADB
Sagarmatha IRD Project	ADB
Livestock Development Project	ADB
Aquaculture Development	ADB
Hill Agriculture Development	ADB
Aquaculture Development	United Nations Development Programme (UNDP)
Vegetable Seed Production	Food and Agriculture Organization of the United Nations (FAO)
Integrated Cereals Project	U.S. Agency for International Development (USAID)
Resource Conservation and Utilization	USAID
Institutional Capacity Building (to develop social-science research capability)	USAID, Agriculture Development Council, International Development Research Centre, Federal Republic of Germany
Lumle Agriculture Center	United Kingdom (UK)
Pakhribas Agriculture Center	UK
Silvicultural Research Project	UK
Tea Development	UK and ADB
National Potato Development	Switzerland
Tinau Watershed Management	Switzerland and Federal Republic of Germany
Livestock Development at Pukhara	Federal Republic of Germany
Janakpur Agricultural Development	Japan
Horticulture Development	Japan
Sericulture Development	Republic of Korea
Karnali/Bheri Integrated Rural Development (projects to collect basic data surveys and resource assessments)	Canadian International Development Agency (CIDA)
Agriculture Resource Inventory	USAID
Land Resource Mapping Project	CIDA
Water and Power Resources Development (surveys and resource assessments)	CIDA
National Farm Management Survey	FAO/UNDP

Source: Unpublished data from the Foreign Aid Division, Ministry of Finance, Nepal.

Table 41—Crop research budget expenditures, 1970/71-1980/81

Project	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81
	(1972/73 Rs 1,000)										
Technical section											
Agricultural botany	670	675	630	210	271	342	314	260	289	260	251
Entomology	457	409	325	618	436	295	334	299	534	309	280
Plant pathology	323	441	340	357	379	262	261	289	320	291	280
Entomology (Khopasi)	n.a.	n.a.	n.a.	n.a.	441	295	388	227	288	220	815
Agricultural stations and farms											
Parwanipur - crops	457	1,081	865	654	627	447	423	376	339	284	287
Tarhara - crops	305	404	698	587	333	299	347	353	267	244	235
Rampur - crops	663	765	671	502	539	283	315	316	328	265	286
Bhairahwa	780	827	281	495	198	442	311	293	300	271	270
Nepalganj	512	437	461	778	1,025	653	1,021	535	408	341	323
Jumla	217	125	75	184	121	144	131	145	143	126	105
Tikapur	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	15	32	24	25
Surkhet	n.a.	n.a.	n.a.	37	45	72	434	196	445	169	173
Doti	109	89	70	76	94	127	115	79	99	91	101
Jobari	n.a.	n.a.	n.a.	n.a.	n.a.	136	120	127	170	114	69
Janakpur	875	708	1,126	395	263	258	243	233	231	175	82
Khumaltar	237	304	249	288	257	186	163	213	217	241	200
Jiri	19	211	n.a.	n.a.	n.a.	155	171	158	225	146	30
Parwanipur - paddy	n.a.	n.a.	n.a.	n.a.	n.a.	245	670	782	770	767	659
Parwanipur - sugarcane	n.a.	n.a.	n.a.	n.a.	n.a.	214	211	190	254	142	141
Rampur - maize	n.a.	n.a.	n.a.	n.a.	n.a.	578	625	1,109	1,508	1,111	1,032
Bhairahwa - wheat	n.a.	n.a.	n.a.	n.a.	n.a.	378	430	526	978	411	789
Cotton research	n.a.	n.a.	n.a.	n.a.	n.a.	172	n.a.	180	198	n.a.	n.a.
Oilseed crop	n.a.	n.a.	n.a.	n.a.	n.a.	164	434	153	316	205	127
Cardamom development	n.a.	n.a.	n.a.	n.a.	112	67	75	133	181	82	89
Ginger development	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	19	18	29	28
Total	5,624	6,476	5,791	5,181	5,141	6,214	7,536	7,206	8,858	6,318	6,678

Sources: Nepal, Auditor General's Office, *Auditor General Annual Report*, various issues (Kathmandu: AGO, various years).

Notes: n.a. means data are not available or project was not yet in existence. Nepal's consumer price indexes (1972/73 = 100), used to convert current rupees expenditure into real expenditure, are as follows: 1970/71 = 88.8; 1971/72 = 90.0; 1972/73 = 100.0; 1973/74 = 114.6; 1974/75 = 134.0; 1975/76 = 141.1; 1976/77 = 141.5; 1977/78 = 155.9; 1978/79 = 161.1; 1979/80 = 177.6; 1980/81 = 201.4.

Table 42—Livestock development budget expenditures, 1970/71-1980/81

Project	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81
	(1972/73 Rs 1,000)										
Livestock development farm											
Tarhara	503	243	303	421	432	318	317	287	297	248	353
Rampur	267	372	355	387	346	303	285	244	n.a.	n.a.	n.a.
Pokhara	240	199	337	518	281	380	300	697	874	2,848	1,876
Nepalganj	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	88	8	94	20	18
Solukhumbu	n.a.	n.a.	n.a.	297	189	208	204	183	175	157	128
Khumal	1,639	1,124	857	538	586	340	405	391	435	360	376
Jiri	264	211	254	241	243	230	253	252	229	198	187
Disease investigation and parasite control											
Tripuraswar	n.a.	n.a.	n.a.	235	348	358	642	532	423	381	350
Sheep farm											
Chitlang	53	89	78	69	125	89	115	97	121	81	78
Karnali	515	222	343	n.a.	n.a.	n.a.	n.a.	155	159	162	234
Tibrikot	n.a.	n.a.	n.a.	277	221	161	173	n.a.	n.a.	n.a.	n.a.
Panchasayakhola	88	174	99	153	175	149	105	115	104	103	89
Pasture development											
Rasuwa	35	36	36	48	81	74	57	54	57	57	56
Khumal	26	35	74	n.a.	n.a.	40	57	51	109	59	49
Yak farm											
Dolpa	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	35	51	123	78	53
Goat farm											
Bandipur	n.a.	n.a.	n.a.	n.a.	n.a.	142	n.a.	125	165	111	131
Sheep and goat development	n.a.	n.a.	n.a.	29	101	418	23	133	131	100	n.a.
Central hatchery											
Balaju	248	83	69	93	87	71	82	81	99	91	84
Parwanipur	246	233	326	286	314	272	299	275	358	200	197
Khumal[a]	145	108	91	155	118	117	339	230	202	211	160
Brooder and hatchery farm											
Nepalganj	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	104	148	62	76	113
Total	4,269	3,129	3,222	3,747	3,647	3,670	3,883	4,109	4,217	5,541	4,532

Sources: Nepal, Auditor General's Office, *Auditor General Annual Report,* various issues (Kathmandu: AGO, various years).
Note: n.a. means data are not available or station was not yet in existence.
[a] Includes central hatcheries in Kathmandu and Jawalakhel.

Table 43—Horticultural farm budget expenditures, 1970/71-1980/81

Project	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81
						(1972/73 Rs 1,000)					
Horticultural farm											
Janakpur	69	70	53	57	67	141	90	72	89	82	79
Panchekhel	n.a.	n.a.	150	94	84	133	179	92	86	82	88
Yagyapuri	135	229	187	235	167	150	211	158	181	175	154
Trisuli	34	58	51	84	84	71	170	78	60	46	56
Tarhara	125	84	122	113	133	205	146	79	71	57	62
Parwanipur	116	67	87	113	70	92	96	92	94	67	69
Helambu	72	42	53	56	56	62	75	273	127	78	85
Dhunibesi	30	58	48	52	67	53	50	60	60	47	54
Sarlahi	n.a.	n.a.	n.a.	n.a.	455	712	452	454	611	364	378
Kirtipur	169	201	274	257	288	269	210	216	308	207	200
Daman	75	124	135	155	143	167	143	142	199	115	114
Solukhumbu	n.a.	n.a.	n.a.	n.a.	n.a.	71	n.a.	65	137	66	154
Baitadi	44	77	64	54	138	88	101	83	87	90	80
Humla	n.a.	30	69	66	60	63	49	62	101	64	59
Jumla	21	20	44	184	171	81	135	143	173	131	92
Rasuwa	36	32	63	89	131	102	89	82	85	73	51
Dailekh	n.a.	n.a.	n.a.	11	17	28	43	262	142	87	144
Nepalganj	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	94	56	53	55
Pokhara	105	133	218	357	540	176	251	194	274	226	172
Godowari	51	180	160	157	169	159	186	214	238	212	191
Jiri	n.a.	n.a.	72	157	188	30	44	53	45	44	40
Kakani	75	101	94	188	146	137	231	173	162	226	149
Mustang	76	n.a.	110	68	161	509	549	428	392	369	320
Pulpa	44	58	47	61	74	216	140	75	88	64	59
Dhankuta	135	160	146	288	396	353	494	472	388	329	300
Potato											
Khumal	215	265	151	120	132	206	285	361	128	235	117
Potato nucleus farm											
Jiri	n.a.	n.a.	n.a.	n.a.	n.a.	60	121	144	55	38	38
Vegetable development and seed production											
Khumal	n.a.	n.a.	200	329	190	315	199	226	188	127	130
Rukum	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	37	88	124	69
Total	1,627	1,989	2,598	3,345	4,127	4,649	4,739	4,884	4,713	3,878	3,559

Sources: Nepal, Auditor General's Office, *Auditor General Annual Report*, various issues (Kathmandu: AGO, various years).
Note: n.a. means data are not available or station was not yet in existence.

Table 44—Fisheries development budget expenditures, 1970/71-1980/81

Project	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81
	(1972/73 Rs 1,000)										
Fisheries development center											
Tarhara	55	76	63	72	59	65	77	72	65	36	49
Pokhara	103	105	97	103	97	911	500	260	237	209	243
Bhairahwa	120	80	90	72	80	187	379	337	369	237	239
Kailali	n.a.	n.a.	n.a.	n.a.	n.a.	61	196	162	213	259	129
Trisuli	330	185	64	50	60	115	81	53	98	49	55
Janakpur	150	152	121	215	213	177	155	115	160	165	135
Godawari	117	77	55	103	149	107	117	98	98	78	83
Parwanipur	90	58	71	38	58	94	87	74	56	63	64
Fatepur	n.a.	96	113	219	151	298	78	61	102	77	59
Hatauda	267	145	226	177	182	173	193	192	192	188	232
Total	1,232	974	900	1,049	1,049	2,188	1,863	1,424	1,590	1,361	1,288

Sources: Nepal, Auditor General's Office, *Auditor General Annual Report*, various issues (Kathmandu: AGO, various years).
Note: n.a. means data are not available or project was not in existence.

Table 45—Food and agricultural input research budget expenditures, 1970/71-1980/81

Project	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81
	(1972/73 Rs 1,000)										
Food research projects											
Food research	446	292	543	121	139	142	203	190	386	324	282
Quality control	n.a.	n.a.	n.a.	246	169	212	295	295	277	247	269
Food testing in Hatauda	110	41	120	336	131	132	136	124	80	66	81
Nutritional research	n.a.	200	251	479	224	326	99	196	151	154	151
Total	556	533	914	1,182	663	812	733	805	894	791	783
Input research projects											
Agricultural engineering	456	592	296	409	306	240	304	334	412	420	238
Soil section	422	400	380	643	472	375	454	486	439	354	300
Total	878	992	676	1,052	778	615	758	820	851	774	538

Sources: Nepal, Auditor General's Office, *Auditor General Annual Report*, various issues (Kathmandu: AGO, various years).
Note: n.a. means data are not available or project was not in existence.

Table 46—Socioeconomic and marketing research budget expenditures, 1975/76-1980/81

Project	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81
			(1972/73 Rs 1,000)			
Food, agricultural, and marketing services	164	202	227	225	195	188
Agricultural marketing research and development	117	124	125	140	131	164
Food situation analysis	31	48	60	52	54	50
Agricultural price analysis and marketing extension	71	93	118	127	87	83
Special studies economic analysis	161	187	247	148	221	219
Total	544	654	777	692	688	704

Sources: Nepal, Auditor General's Office, *Auditor General Annual Report*, various issues (Kathmandu: AGO, various years).

Note: Socioeconomic and marketing research expenditures, 1975/76-1980/81, annual growth rate = 5.31 percent (t-statistic = 1.79).

Table 47—Classification of budget expenditures

Budget Code	Type of Expenditure
1	Salary and wages
2	Allowances
3	Travel allowance and daily allowance
4	Services: printing and binding, postage, telephone, telex, bank service charges, advertising, transportation and freight charges for moving property
5	Rent
6	Repair and maintenance
7	Expendable goods (with life less than one year)
7.1	Office stationery
7.2	Books, newspapers, and magazines
7.3	Fuel
7.4	Clothes and foodgrains for junior staff
7.5	Other expendable goods
8	Grants-in-aid, contributions, and rewards
9	Unforeseen
10	Durable goods (with life less than one year)
10.1	Furniture
10.2	Transport devices
10.3	Tools and machinery
11	Purchase of land and buildings
11.1	Purchase of land
11.2	Purchase of buildings
12	Construction and improvements
12.1	Building construction and improvements
12.2	Other construction and improvements

Source: Nepal, Ministry of Finance, *Income-Expenditure Estimated Budget, 1982/83* (Kathmandu: MOF, 1982).

Table 48—Trained personnel in agriculture, by institution, 1983

Institution	Ph.D.	M.S.	B.S. or Equivalent	Total
Ministry of Agriculture Secretariat	5	25	0	30
Department of Agriculture	9	137	400	546
Department of Livestock and Animal Health	3	26	91	120
Department of Food and Agricultural Marketing Services	4	32	3	39
Central Food Research Laboratory	2	30	0	32
Agriculture Development Bank	1	16	53	70
Agriculture Inputs Corporation	0	4	21	25
Agricultural Projects Services Centre	5	70	2	77
Institute of Agriculture and Animal Science	5	63	20	88
Dairy Development Corporation	0	11	14	25
Total	34	414	604	1,052

Source: A survey of personnel in agriculture by the author, 1983.

Table 49—Trained personnel in the Ministry of Agriculture and its parastatals, by discipline, 1983

Discipline	Ph.D	M.S.	B.S. or Equivalent	Total
Agronomy	3	23	55	81
Botany	3	16	10	29
Horticulture	1	25	40	66
Animal husbandry	1	13	37	51
Veterinary science	2	15	55	72
Agricultural economics	9	104	0	113
Agricultural extension	1	29	100	130
Rural sociology	0	5	0	5
Entomology	2	14	7	23
Plant pathology	1	15	21	37
Soil science	0	14	15	29
Fisheries	0	14	8	22
Agricultural engineering	0	11	27	38
Agricultural statistics and mathematics	2	17	3	22
Food technology	0	13	0	13
Nutrition	2	3	0	5
Business administration	0	4	0	4
Geography	1	0	0	1
Chemistry	1	10	6	17
Home science	0	2	1	3
General agriculture	0	0	188	188
Dairy technology	0	4	11	15
Total	29	351	584	964

Source: A survey of personnel in agriculture by the author, 1983.

APPENDIX 2: METHODOLOGY FOR DETERMINING GROWTH RATES AND DECOMPOSITION OF GROWTH TRENDS

Growth Rates

In order to compute annual growth rates, the exponential curve $Y = ab^t$, which represents a trend with constant rate of increase or decrease, is estimated. In logarithmic form it becomes

$$\log Y = \log a + t \log b,$$

where y = the value of the variable in year t, and t = time; 1970/71 = 1, 1971/72 = 2 . . . . Anti-log of log b gives the value of b and the growth rate $G = (b - 1) \times 100$, expressed in percentage.

Decomposition of Growth Trends

The decomposition of agricultural growth trends was analyzed employing multiplicative schemes developed by Minhas:

$$A_t\sum_c a_{ct}Y_{ct}P_c / A_0\sum_c a_{c0}Y_{c0}P_c = (A_t/A_0)(\sum_c a_{c0}Y_{ct}P_c / \sum_c a_{c0}Y_{c0}P_c)(\sum_c a_{ct}Y_{c0}P_c / \sum_c a_{c0}Y_{c0}P_c)$$
$$(\sum_c a_{ct}Y_{ct}P_c / \sum_c a_{ct}Y_{c0}P_c \times \sum_c a_{c0}Y_{c0}P_c / \sum_c a_{c0}Y_{ct}P_c),$$

where

A_t = gross cropped area during period t,

a_{ct} = (A_{ct}/A_t) = proportion of area under crop c (A_{ct}) to the gross cropped area during period t,

Y_{ct} = physical output per hectare of crop c during period t, and

P_c = the constant price weights (1975/76) assigned to each crop.

This formulation expresses the index number of output as a multiple, respectively, of the index number of area, change in crop yields, change in cropping patterns, and a residual component that is the interaction between cropping pattern and yield components.

Fitting an exponential time-trend to each series of index numbers produces an additive scheme for growth,

$$G = G_A + G_Y + G_a + G_{ay},$$

where

G = growth rates of gross agricultural output,

G_A = growth rates of gross cropped area,

G_Y = growth rates of contribution of the yield effect,

G_a = growth rates of contribution of the cropping pattern effect, and

G_{ay} = residual components, such as growth rates of contribution of interaction between cropping pattern and yield components.

The residual component, G_{ay}, is obtained by subtracting $(G_A + G_Y + G_a)$ from G.

BIBLIOGRAPHY

Andrew, Chris O., and Hildebrand, Peter E. *Planning and Conducting Applied Agricultural Research.* Boulder, Colo.: Westview Press, 1982.

Arndt, Thomas M.; Dalrymple, Dana G.; and Ruttan, Vernon W., eds. *Resource Allocation and Productivity in National and International Agricultural Research.* Minneapolis: University of Minnesota Press, 1977.

Asian Development Bank/Nepal. *Nepal Agricultural Sector Strategy Study,* vols. 1 and 2. Kathmandu: ADB and Nepal Government Press, 1982.

Bangladesh Agricultural Research Council. *Agricultural Research in Bangladesh: Contributing to National Development.* Dhaka: BARC, 1983.

Boyce, James K., and Evenson, Robert E. *Agricultural Research and Extension Programs.* New York: Agricultural Development Council, Inc., 1975.

Busch, Lawrence, and Lacy, William B. *Science, Agriculture and the Politics of Research.* Boulder, Colo.: Westview Press, 1982.

Dahlberg, Kenneth A., ed. *New Directions for Agriculture and Agricultural Research: Neglected Dimensions and Emerging Alternatives.* Totowa, N.J.: Rowman and Allanheld, 1985.

Dalrymple, Dana G. *Development and Spread of High-Yielding Varieties of Wheat and Rice in the Less-Developed Nations.* Foreign Agricultural Report 95. Washington, D.C.: U.S. Department of Agriculture, September 1978.

Eicher, Carl K., and Staatz, John M., eds. *Agricultural Development in the Third World.* Baltimore and London: The Johns Hopkins University Press, 1984.

Evenson, Robert E., and Kislev, Yoav. *Agricultural Research and Productivity.* New Haven and London: Yale University Press, 1975.

Food and Agriculture Organization of the United Nations. *Seed Status Survey Report.* Rome: FAO, 1981.

Food and Agriculture Organization of the United Nations/World Bank Cooperative Program. *Nepal Agricultural Research Review Mission Report.* Rome: FAO, 1984.

Hayami, Yujiro, and Ruttan, Vernon W. *Agricultural Development: An International Perspective.* Baltimore and London: The Johns Hopkins University Press, 1985.

Hill, John M. *A Fertilizer Strategy for Nepal.* Muscle Shoals, Ala.: International Fertilizer Development Center, 1982.

Idachaba, F. S. *Agricultural Research Policy in Nigeria.* Research Report 17. Washington, D.C.: International Food Policy Research Institute, 1980.

International Fund for Agricultural Development. *Report of the Special Programming Mission to Nepal.* Rome: IFAD, 1979.

Matherma, S. B., et al. "Notes on the Economics of the Use of Inorganic Fertilizer." Paper presented at the Eighth Summer Crops Workshop at Rampur, January 1981.

Mellor, John W. *The New Economics of Growth: A Strategy for India and the Developing World.* A Twentieth Century Fund Study. Ithaca and London: Cornell University Press, 1976.

Nepal. *Pay Commission Report.* Kathmandu: Government Press, 1983.

Nepal, Agricultural Projects Services Centre. *Nepal: Trained Manpower for the Agricultural Sector,* vols. 1 and 2. Kathmandu: APROSC, 1981.

———. *Perspective Land Use Plan (1985-2005).* Kathmandu: APROSC, 1986.

Nepal, Agriculture Inputs Corporation. *Basic Statistics of Agricultural Inputs in Nepal.* Kathmandu: AIC, 1983.

Nepal, Auditor General's Office. *Auditor General Annual Report,* various issues. Kathmandu: AGO, various years.

Nepal, Central Bureau of Statistics. *Sample Census of Agriculture, 1981.* Kathmandu: CBS, 1981.

Nepal, Department of Agriculture. *The Integration of Research and Extension in Farmers' Fields: The Terminal Report of the Integrated Cereals Project.* Kathmandu: Ministry of Agriculture, 1985.

———. *A Proposal for Organizing Agricultural Research in Nepal.* Mid-term preliminary draft, April 7-May 27, 1977. Kathmandu: Ministry of Agriculture, 1977.

Nepal, Ministry of Agriculture. *A General Outline of the First Five-Year Plan for Agriculture* Kathmandu: MOA, 1957.

———. *Ten-Year Agriculture Plan.* Kathmandu: MOA, 1972.

Nepal, Ministry of Finance. *Budget Speeches,* various fiscal years. Kathmandu: MOF, various years.

———. *Income-Expenditure Estimated Budget, 1982/83.* Kathmandu: MOF, 1982.

———. *Nepal: Economic Survey,* various issues. Kathmandu: MOF, various years.

Nepal, National Planning Commission. *Agriculture Plans and Programs for 1982/83.* Kathmandu: NPC, 1982.

———. *The Fourth Plan, 1970-75.* Kathmandu: NPC, 1970.

———. *The Sixth Five-Year Plan* (1980-85). Kathmandu: NPC, 1980.

Nepal, National Planning Commission, Central Bureau of Statistics. *National Sample Census of Agriculture 1981/82.* Kathmandu: CBS, 1985.

Nepal Rastra Bank. *Agricultural Credit Review Survey.* Kathmandu: Nepal Rastra Bank, 1980.

Nepal/World Bank. *Allocation of Development Expenditure in the Public Sector.* An economic memorandum on Nepal. Kathmandu: Ministry of Finance.

Oram, Peter A., and Bindlish, Vishva. *Resource Allocations to National Agricultural Research: Trends in the 1970s.* The Hague and Washington, D.C.: International Service for National Agricultural Research/International Food Policy Research Institute, 1981.

Paulino, Leonardo A. *Food in the Third World: Past Trends and Projections to 2000.* Research Report 52. Washington, D.C.: International Food Policy Research Institute, 1986.

Pinstrup-Andersen, Per. *Agricultural Research and Technology in Economic Development.* London and New York: Longman, 1982.

Rai, Arun Kumar. *National Report on Sugarcane—1982/83.* Kathmandu: National Sugarcane Development Programme, Department of Agriculture, 1983.

Randhawa, M. S. *A History of the Indian Council of Agricultural Research, 1929-1979.* New Delhi: Indian Council of Agricultural Research, 1979.

Remenyi, J. V., ed. *Agricultural Systems Research for Developing Countries.* ACIAR Proceedings No. 11. Proceedings of an international workshop held at Hawkesbury Agricultural College, Richmond, N.S.W., Australia, May 12-15, 1985.

Ruttan, Vernon W. *Agricultural Research Policy.* Minneapolis: University of Minnesota Press, 1982.

———. "Reforming the Global Agricultural Research Support System." *Bulletin* 83-2, Economic Development Center, University of Minnesota (March 1983).

Shrestha, T. B. *Job Environment and Job Consciousness of Agricultural Graduates Under the Ministry of Food, Agriculture and Irrigation, 1978-1979.* Kathmandu: Agricultural Projects Services Centre, 1980.

U.S. Agency for International Development. *Nepal Integrated Cereals Project Evaluation Report.* Kathmandu: USAID, 1983.

———. *Project History and Analysis Report—Agricultural Extension and Training.* 367-11-110-054. Washington, D.C.: USAID, 1965.

World Bank. *Agricultural Research and Extension: An Evaluation of the World Bank's Experience.* Washington, D.C.: World Bank, 1985.

———. *Agricultural Research Sector Policy Paper.* Washington, D.C.: World Bank, 1981.

———. *Nepal: Development Performance and Prospects.* A World Bank Country Study. Washington, D.C.: World Bank, 1979.

———. *Nepal: Policies and Prospects for Accelerated Growth.* Washington, D.C.: World Bank, 1981.

Yadav, Ram P. "Institutional Arrangements for Agricultural Research in Nepal." In *Research, Productivity and Mechanization in Nepalese Agriculture.* Edited by Bhavani Dhungana. Seminar report, Center for Economic Development and Administration, Tribhuvan University, November 1976.

RECENT IFPRI RESEARCH REPORTS (continued)

42 *THE EFFECTS OF FOOD PRICE AND SUBSIDY POLICIES ON EGYPTIAN AGRICULTURE*, November 1983, by Joachim von Braun and Hartwig de Haen

41 *RURAL GROWTH LINKAGES: HOUSEHOLD EXPENDITURE PATTERNS IN MALAYSIA AND NIGERIA*, September 1983, by Peter B. R. Hazell and Ailsa Röell

40 *FOOD SUBSIDIES IN EGYPT: THEIR IMPACT ON FOREIGN EXCHANGE AND TRADE*, August 1983, by Grant M. Scobie

39 *THE WORLD RICE MARKET: STRUCTURE, CONDUCT, AND PERFORMANCE*, June 1983, by Ammar Siamwalla and Stephen Haykin

38 *POLICY MODELING OF A DUAL GRAIN MARKET: THE CASE OF WHEAT IN INDIA*, May 1983, by Raj Krishna and Ajay Chhibber

37 *SERVICE PROVISION AND RURAL DEVELOPMENT IN INDIA: A STUDY OF MIRYALGUDA TALUKA*, February 1983, by Sudhir Wanmali

36 *AGRICULTURE AND ECONOMIC GROWTH IN AN OPEN ECONOMY: THE CASE OF ARGENTINA*, December 1982, by Domingo Cavallo and Yair Mundlak

35 *POLICY OPTIONS FOR THE GRAIN ECONOMY OF THE EUROPEAN COMMUNITY: IMPLICATIONS FOR DEVELOPING COUNTRIES*, November 1982, by Ulrich Koester

34 *EGYPT'S FOOD SUBSIDY AND RATIONING SYSTEM: A DESCRIPTION*, October 1982, by Harold Alderman, Joachim von Braun, and Sakr Ahmed Sakr

33 *AGRICULTURAL GROWTH AND INDUSTRIAL PERFORMANCE IN INDIA*, October 1982, by C. Rangarajan

32 *FOOD CONSUMPTION PARAMETERS FOR BRAZIL AND THEIR APPLICATION TO FOOD POLICY*, September 1982, by Cheryl Williamson Gray

31 *SUSTAINING RAPID GROWTH IN INDIA'S FERTILIZER CONSUMPTION: A PERSPECTIVE BASED ON COMPOSITION OF USE*, August 1982, by Gunvant M. Desai

30 *INSTABILITY IN INDIAN FOODGRAIN PRODUCTION*, May 1982, by Peter B. R. Hazell

29 *GOVERNMENT POLICY AND FOOD IMPORTS: THE CASE OF WHEAT IN EGYPT*, December 1981, by Grant M. Scobie

28 *GROWTH AND EQUITY: POLICIES AND IMPLEMENTATION IN INDIAN AGRICULTURE*, November 1981, by J. S. Sarma

27 *AGRICULTURAL PRICE POLICIES UNDER COMPLEX SOCIOECONOMIC AND NATURAL CONSTRAINTS: THE CASE OF BANGLADESH*, October 1981, by Raisuddin Ahmed

26 *FOOD SECURITY IN THE SAHEL: VARIABLE IMPORT LEVY, GRAIN RESERVES, AND FOREIGN EXCHANGE ASSISTANCE*, September 1981, by John McIntire

25 *INSTABILITY IN INDIAN AGRICULTURE IN THE CONTEXT OF THE NEW TECHNOLOGY*, July 1981, by Shakuntla Mehra

24 *THE EFFECTS OF EXCHANGE RATES AND COMMERCIAL POLICY ON AGRICULTURAL INCENTIVES IN COLOMBIA: 1953-1978*, June 1981, by Jorge García García

23 *GOVERNMENT EXPENDITURES ON AGRICULTURE IN LATIN AMERICA*, May 1981, by Victor J. Elías

22 *ESTIMATES OF SOVIET GRAIN IMPORTS IN 1980-85: ALTERNATIVE APPROACHES*, February 1981, by Padma Desai

Ram P. Yadav is the deputy director of the International Centre for Integrated Mountain Development in Nepal. He was a visiting research fellow at IFPRI from 1982 to 1984.

RECENT IFPRI RESEARCH REPORTS

61 *THE PILOT FOOD PRICE SUBSIDY SCHEME IN THE PHILIPPINES: ITS IMPACT ON INCOME, FOOD CONSUMPTION, AND NUTRITIONAL STATUS,* August 1987, by Marito Garcia and Per Pinstrup-Andersen

60 *POPULATION POLICY AND INDIVIDUAL CHOICE: A THEORETICAL INVESTIGATION,* June 1987, by Marc Nerlove, Assaf Razin, and Efraim Sadka

59 *PRODUCTION INCENTIVES IN PHILIPPINE AGRICULTURE: EFFECTS OF TRADE AND EXCHANGE RATE POLICIES,* May 1987, by Romeo M. Bautista

58 *THE FOOD STAMP SCHEME IN SRI LANKA: COSTS, BENEFITS, AND OPTIONS FOR MODIFICATION,* March 1987, by Neville Edirisinghe

57 *CEREAL FEED USE IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 2000,* December 1986, by J. S. Sarma

56 *THE EFFECTS OF TRADE AND EXCHANGE RATE POLICIES ON AGRICULTURE IN ZAIRE,* November 1986, by Tshikala B. Tshibaka

55 *THE EFFECTS OF TRADE AND EXCHANGE RATE POLICIES ON AGRICULTURE IN NIGERIA,* October 1986, by T. Ademola Oyejide

54 *WEATHER AND GRAIN YIELDS IN THE SOVIET UNION,* September 1986, by Padma Desai

53 *REGIONAL COOPERATION TO IMPROVE FOOD SECURITY IN SOUTHERN AND EASTERN AFRICAN COUNTRIES,* July 1986, by Ulrich Koester

52 *FOOD IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 2000,* June 1986, by Leonardo A. Paulino

51 *DETERMINANTS OF AGRICULTURAL POLICIES IN THE UNITED STATES AND THE EUROPEAN COMMUNITY,* November 1985, by Michel Petit

50 *GOVERNMENT EXPENDITURES ON AGRICULTURE AND AGRICULTURAL GROWTH IN LATIN AMERICA,* October 1985, by Victor J. Elías

49 *LIVESTOCK PRODUCTS IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 1990 AND 2000,* April 1985, by J. S. Sarma and Patrick Yeung

48 *RURAL HOUSEHOLD USE OF SERVICES: A STUDY OF MIRYALGUDA TALUKA, INDIA,* March 1985, by Sudhir Wanmali

47 *EVOLVING FOOD GAPS IN THE MIDDLE EAST/NORTH AFRICA: PROSPECTS AND POLICY IMPLICATIONS,* December 1984, by Nabil Khaldi

46 *THE EFFECTS ON INCOME DISTRIBUTION AND NUTRITION OF ALTERNATIVE RICE PRICE POLICIES IN THAILAND,* November 1984, by Prasarn Trairatvorakul

45 *THE EFFECTS OF THE EGYPTIAN FOOD RATION AND SUBSIDY SYSTEM ON INCOME DISTRIBUTION AND CONSUMPTION,* July 1984, by Harold Alderman and Joachim von Braun

44 *CONSTRAINTS ON KENYA'S FOOD AND BEVERAGE EXPORTS,* April 1984, by Michael Schluter

43 *CLOSING THE CEREALS GAP WITH TRADE AND FOOD AID,* January 1984, by Barbara Huddleston

(continued on inside back cover)

RESEARCH REPORT 63

R5620-1.8F (A) 186

INCOME AND NUTRITIONAL EFFECTS OF THE COMMERCIALIZATION OF AGRICULTURE IN SOUTHWESTERN KENYA

Eileen T. Kennedy
Bruce Cogill

November 1987

INTERNATIONAL
FOOD
POLICY
RESEARCH
INSTITUTE

The **International Food Policy Research Institute** was established in 1975 to identify and analyze alternative national and international strategies and policies for meeting food needs in the world, with particular emphasis on low-income countries and on the poorer groups in those countries. While the research effort is geared to the precise objective of contributing to the reduction of hunger and malnutrition, the factors involved are many and wide-ranging, requiring analysis of underlying processes and extending beyond a narrowly defined food sector. The Institute's research program reflects worldwide interaction with policymakers, administrators, and others concerned with increasing food production and with improving the equity of its distribution. Research results are published and distributed to officials and others concerned with national and international food and agricultural policy.

The Institute receives support as a constituent of the Consultative Group on International Agricultural Research from a number of donors including the United States, the World Bank, Japan, Canada, the United Kingdom, the Netherlands, Australia, the Ford Foundation, Italy, Norway, the Federal Republic of Germany, India, the Philippines, Switzerland, Belgium, and the People's Republic of China. In addition, a number of other governments and institutions contribute funding to special research projects.

Board of Trustees

Dick de Zeeuw
Chairman, Netherlands

Ralph Kirby Davidson
Vice Chairman, U.S.A.

Eliseu Roberto de Andrade Alves
Brazil

Yahia Bakour
Syria

Ivan L. Head
Canada

Dharma Kumar
India

Anne de Lattre
France

James R. McWilliam
Australia

Philip Ndegwa
Kenya

Saburo Okita
Japan

Sukadji Ranuwihardjo
Indonesia

Theodore W. Schultz
U.S.A.

Leopoldo Solís
Mexico

M. Syeduzzaman
Bangladesh

Charles Valy Tuho
Cote d'Ivoire

John W. Mellor, Director
Ex Officio, U.S.A.

INCOME AND NUTRITIONAL EFFECTS OF THE COMMERCIALIZATION OF AGRICULTURE IN SOUTHWESTERN KENYA

Eileen T. Kennedy
Bruce Cogill

Research Report 63
International Food Policy Research Institute
November 1987

Copyright 1987 International Food Policy Research Institute.

All rights reserved. Sections of this report may be reproduced without the express permission of but with acknowledgment to the International Food Policy Research Institute.

Library of Congress Cataloging
in Publication Data

Kennedy, Eileen T., 1947-
Income and nutritional effects of the commercialization of agriculture in southwestern Kenya.

(Research report ; 63)
"November 1987."
Bibliography: p.60.
1. Agriculture—Economic aspects—Kenya—South Nyanza District. 2. Food supply—Kenya—South Nyanza District. 3. Sugarcane industry—Kenya—South Nyanza District. 4. Corn industry—Kenya—South Nyanza District. 5. Agricultural wages—Kenya—South Nyanza District. 6. Agricultural laborers—Kenya—South Nyanza District—Nutrition. 7. Cost and standard of living—Kenya—South Nyanza District. 8. Diseases—Kenya—South Nyanza District. 9. Nutrition policy—Kenya—South Nyanza District. I. Cogill, Bruce, 1952- II. Title. III. Series: Research report (International Food Policy Research Institute) ; 63.

HD2126.5.Z9S685 1987 338.1'09676'29
87-29668 ISBN 0-89629-065-4

CONTENTS

Foreword

1. Summary 9

2. Research Design and Survey Methods 11

3. Comparative Analysis of Maize and Sugar Cropping Patterns in South Nyanza 16

4. Income and Expenditure 29

5. The Effect of Commercial Agriculture on Energy Consumption Patterns 35

6. Morbidity Patterns of Women and Children 42

7. Determinants of Nutritional Status of Women and Preschoolers 50

8. Conclusions 57

Bibliography 60

TABLES

1. Data collected in the survey, June 1984 to February 1985 13
2. Composition of the sample 15
3. Characteristics of households in the study sample, 1984/85 15
4. Land allocated to specific crops by agricultural households, by season, 1984/85 17
5. Production characteristics of local and hybrid maize and sugarcane by agricultural households, long-rain season, 1984/85 18
6. Fertilizer use by crop, long-rain season, 1984/85 19
7. Total household labor and hired labor for major crops, long-rain season, 1984/85 19
8. Summary of the costs of factory inputs per hectare of sugarcane, by task 21
9. Time allocation of women 22
10. Summary of sugar yield, income, and inputs per hectare, by harvest, 1978-84 23
11. Summary of yield and income from sugar, by harvest and by year of planting, 1978-82 25
12. Net returns for sugar and local maize, 1984 26
13. Net returns for a drought-year sugarcane crop, 1980, compared with a drought-year maize crop, 1984 26
14. Comparison of returns to land and household labor for maize and sugarcane, 1980-84 27
15. Total annual income and expenditures per capita, by activity group, 1984/85 29
16. Mean annual income per capita per year, by source for activity groups, 1984/85 30
17. Annual food and nonfood expenditures per capita, by activity group, 1984/85 31
18. Annual expenditures on and shares of purchased versus own-produced food, by activity group, 1984/85 31
19. Total food expenditures per capita per year and average budget share, by major food group, 1984/85 32
20. Nonfood expenditures per capita per year for major categories, by activity group, 1984/85 33
21. Household energy intake per capita, by activity group and season, 1984/85 35
22. Household energy intake per adult equivalent unit, by activity group and season, 1984/85 36
23. Percentage of energy adequacy per adult equivalent unit, by activity group and season, 1984/85 36
24. Percentage of energy-deficient households, by activity group and season, 1984/85 37

25. Protein intake per adult equivalent unit, by activity group and season, 1984/85 38
26. Energy intake of preschoolers and percentage of requirements met, by activity group, 1984 39
27. Regression of daily intake of household kilocalories for the total sample and for agricultural households alone 40
28. Percentage of time ill with any illness and with diarrhea, preschoolers and women, by activity group, 1984/85 43
29. Percentage of time ill with any illness and with diarrhea, preschoolers and women, by per capita income quartile, 1984/85 43
30. Percentage of preschoolers' time ill with any illness, by age of child and activity group, 1984/85 44
31. Percentage of time ill with any illness for preschoolers aged 6 to 72 months, by indicators of nutritional status and income quartile, 1984/85 45
32. Regression equations for total time ill and time ill with diarrhea for preschoolers 46
33. Regression equations for total time ill and time ill with diarrhea for women 48
34. Mean values of key anthropometric indicators expressed as a percentage of NCHS reference median and Z-scores for children aged 6 to 72 months, by activity group 51
35. Average Z-scores and percentage of the standard length-for-age, weight-for-age, and weight-for-length for preschoolers, stratified by quartiles of annual marketed agricultural income 52
36. Indicators of nutritional status (expressed as Z-scores) for children aged 6 to 72 months for agricultural households, by income quartile 53
37. Percentage of children between the ages of 6 and 72 months below common cutoffs for nutritional status, by activity group, 1984/85 54
38. Z-score regressions for length-for-age, weight-for-age, and weight-for-length for preschoolers aged 6 to 72 months 55
39. Weight by rounds, and height for adult women in each activity group 56
40. Regressions for women's weight and weight-for-height squared 56
41. Decisionmaking on food expenditures and sugarcane income 59

ILLUSTRATION

Relationship between commercial agriculture and production, income, consumption, and health 12

FOREWORD

The commercialization of agriculture is the cornerstone of economic development in most developing countries. Yet relatively little is known about the income and nutritional effects of increasing commercial agriculture. The present study by Eileen Kennedy and Bruce Cogill is the first in a series of studies conducted by IFPRI in Africa, Asia, and Central America to assess the effects of the commercialization of agriculture on production, consumption, and nutritional status.

In 1983 IFPRI was invited by the government of Kenya to undertake a study of the production and consumption effects of a smallholder sugarcane contracting scheme in Southwestern Kenya. The resulting study is unusual because it uses a random sample of farmers at various stages of sugarcane farming and collected data over two maize-growing seasons. Detailed data are presented on the trade-offs between the major food crop, maize, and the contracted sugarcane crop. Furthermore, it traces the links between income from sugarcane and the associated effects on food intake, morbidity, and nutritional status of women and children.

Incomes of the farmers are increasing significantly as a result of participation in the sugarcane outgrowers' scheme. However, this increased income does not translate into improvements in child health and nutritional status, at least in the short run. The health/sanitation environment is a key determinant of a child's morbidity and growth. The agricultural/health linkages need to be considered in anticipating the impact of agricultural development strategies on preschoolers.

The report identifies positive effects of commercial agriculture and ways to enhance these and thus allows policymakers to use these data to fine-tune future schemes of this type.

John W. Mellor

Washington, D.C.
November 1987

ACKNOWLEDGMENTS

The people and government of Kenya contributed immensely to this research. The support, advice, and perspective provided by the dedicated research panel of John Omuse, Ruth Oniang'o, Dismas Nyongesa, Luke Wasonga, and Festus Omoro are greatly appreciated. The families in South Nyanza who gave freely of their time, the survey enumerators and supervisors, the various government agencies, and the South Nyanza Sugar Company all made the research possible and meaningful.

A special note of thanks to Michael Latham of Cornell University, not only for his review and comment on earlier drafts of this manuscript, but also for his help at critical stages in initiating field work for the project.

Thanks also to Per Pinstrup-Andersen, Joachim von Braun, and John W. Mellor for their thorough review of the manuscript. The comments of Dayanatha Jha, Thomas Reardon, and two anonymous reviewers are appreciated. The tremendous research assistance provided by Elizabeth Jacinto and Mustapha Rechache is also acknowledged.

Finally, appreciation is expressed to the staff of the International Fund for Agricultural Development (IFAD) for their comments and suggestions on an earlier draft of this manuscript. A personal note of thanks must go to Abbas Kesseba for his genuine support of this research from its inception. Without his help, the project would not have materialized.

Financial assistance for the research was provided by the International Fund for Agricultural Development.

1

SUMMARY

Commercialization of agriculture is a controversial issue. While a number of studies have indicated that the effects of cash cropping on nutrition have been disastrous, others have found a positive or at least a neutral effect.

This research, which was initiated at the request of the government of Kenya and conducted jointly with the National Council for Science and Technology of Kenya and Kenyatta University, aims to evaluate the effects of a shift from maize to sugarcane on agricultural production, income, expenditures, consumption, and health and nutritional status.

The research was conducted in South Nyanza district, the area of Kenya with the highest mortality rate from birth to two years of age—216 per 1,000—of any district of Kenya. By encouraging farmers to move into commercial agriculture, the government hoped to improve the general health and well-being of low-income farm households.

A random sample of smallholder farmers in various stages of sugarcane production was selected from those under contract to a sugar factory in South Nyanza, Kenya. Nonsugar farmers (those not growing sugar under contract) with similar characteristics were randomly chosen from a mapping of next-nearest neighbors to ensure geographical similarity. A random sample of merchants and the landless were included in order to assess the total effects of cash cropping on the community.

Agriculture in the area is dominated by smallholder agriculture with maize being the major crop. Farmers mostly use a low-input technology, relying heavily on household labor. For maize, 95 percent of labor is provided by household members. Only 16 percent of the sugar farmers and 6 percent of the nonsugar farmers use any inorganic fertilizer.

As sugarcane production expands, it mainly replaces maize area. Of the plots planted in sugarcane, 95 percent were formerly used for maize. In 1984, a drought year, returns to land were similar for maize and sugarcane. Under normal climatic conditions, however, maize usually produces a larger return to land than sugarcane. The picture is dramatically different when the returns per day of household labor are analyzed. The return to labor for sugar is three times the daily agricultural wage rate and significantly higher than the return to maize.

Incomes of the farmers participating in the sugarcane outgrowers' scheme are significantly higher than those of nonsugar farmers. Most of the difference in income comes from marketed agricultural surplus—36 percent of the income in sugar-producing households compared to 20 percent for nonsugar farmers. Fifteen percent of the sugar farmers' income is from participation in the outgrowers' program.

Much of the incremental income earned by sugar farmers is spent on nonfood expenditures. Merchants and sugar-producing households spend more on housing and education than other households in the sample. Although these expenditures presumably have a beneficial effect, they do not appear to produce a nutritional benefit for preschoolers—at least in the short run.

However, the increased income positively affects household calorie consumption, and the percentage of income derived from sugar has an additional positive effect above and beyond the pure income effect. For each 1 percent increase in sugarcane income, household energy intake increases by 24 calories. At the mean, sugar income contributes an additional 360 kilocalories per day to household energy intake. Some fine-tuning of commercial agricultural schemes could help maximize the potential impact of the increased income on household and preschooler nutritional status.

Illness is so prevalent in South Nyanza that 50-70 percent of the children and women are sick at any given time, on average, one out of every four days. Illness tends to be most prevalent in the preharvest, rainy season. Morbidity patterns are one of the major determinants of preschooler nutritional status. The more a child is ill or has diarrhea, the less improvement will be shown in nutritional status.

Children from households headed by females consistently have better nutritional status than preschoolers from other types of households. Girls do better than boys and older children do better than younger in many of the growth parameters. There is also some evidence that income controlled by women correlates with improved nutritional status, indicating that women are more likely to spend on food and health care.

The positive effect of the sugarcane scheme on income is apparent and should not be understated. However, the data suggest that one of the major pathways to improving nutritional status is improvement of health and the sanitation environment. The health care infrastructure must be taken into consideration when policymakers are trying to anticipate the effects of agricultural policies and programs. Low-cost, low-technology innovations with a preventive focus can have a high payoff in child health.

2

RESEARCH DESIGN AND SURVEY METHODS

The appropriate role of export crop or cash crop production in many developing countries is a politically volatile issue.[1] Many governments are encouraging the increased production of cash crops as a means of generating and saving foreign exchange earnings, on the one hand, while stressing the production of food crops for domestic consumption on the other hand. At times, these goals appear to be in conflict.

In Kenya, there has been some concern that in areas with increased cash cropping, particularly increased sugarcane production, preschooler nutritional status has deteriorated. This concern is reflected in a 1981 Kenyan National Food Policy Paper, which indicated that "particular attention be given to safeguarding the family diet of small farmers who switch from food crop to cash crop production."[2] Little is known, however, about the effects on nutrition of the process of commercialization of agriculture. This is somewhat surprising given the importance of export crops/cash crops in the economies of many developing countries. A recent review of the income and nutritional effects of cash crop production suggests mixed results.[3] While some studies show a negative effect of cash crop production on consumption and nutritional status, an equal number of studies show a positive or neutral effect. What then are the health and nutritional effects of commercialization of agriculture?

This study was conducted to evaluate the effects of cash crop production on agricultural production, income, and food consumption and to assess the impact of cash cropping on the health and nutritional status of women and preschoolers. In addition, the research concentrated on identifying the process leading to these outcomes.

Conceptual Approach and Survey Methods

Almost all previous research on the nutritional effects of cash crop production has concentrated on evaluating outcomes; few studies have attempted to elucidate the process through which commercial agriculture may affect household behavior. Thus the results of the studies—whether positive or negative—have limited usefulness in formulating policy.

The figure below presents a simplified conceptual model of pathways through which cash crop production can potentially influence health and nutritional status.[4] There are a complex set of issues and linkages that need to be understood in order to evaluate the effects of cash crop production. Past work has concentrated on a limited number of household-level effects—mainly household agricultural production. Noticeably absent from most studies is any research related to an assessment of the effects of cash cropping on intrahousehold dynamics.

As can be seen from the figure, cash cropping can potentially influence factors at the household level by affecting agricultural

---

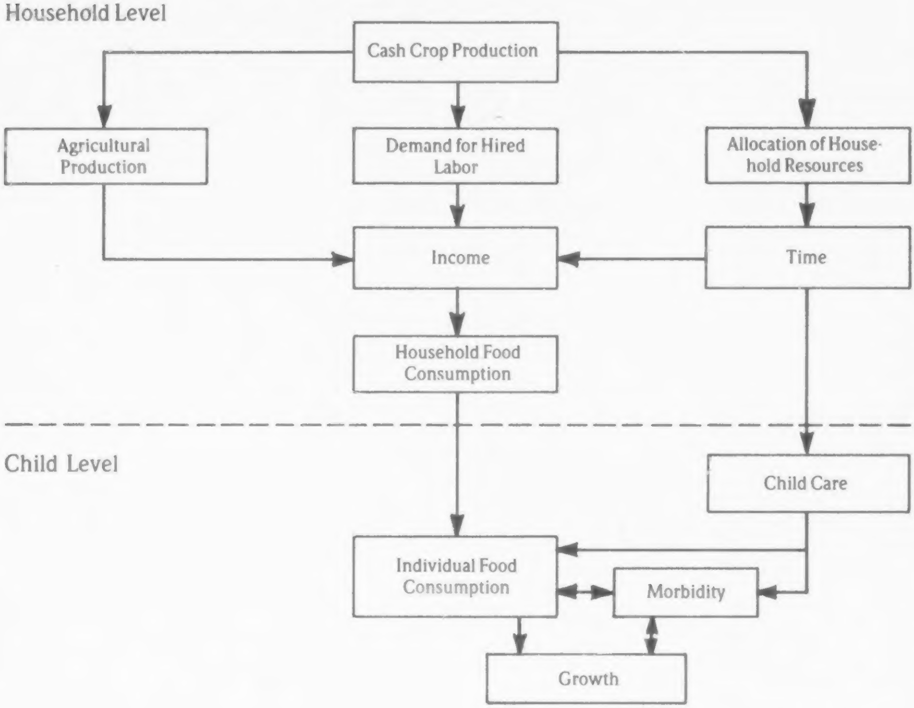
[1] The terms "export crops" and "cash crops" are often used interchangeably in the literature, and this creates some confusion. Export crops are those that are exported from the country; they can be food or nonfood crops. Cash crops are commodities that are sold, which can also be either food or nonfood crops.

[2] Republic of Kenya. *National Food Policy Paper,* Sessional Paper 4 (Nairobi: Government Printer, 1981).

[3] Joachim von Braun and Eileen Kennedy, *Commercialization of Subsistence Agriculture: Income and Nutritional Effects in Developing Countries,* Working Paper on Commercialization of Agriculture and Nutrition 1 (Washington, D.C.: International Food Policy Research Institute, 1986).

[4] A more detailed discussion of each of these pathways is contained in von Braun and Kennedy, *Commercialization of Subsistence Agriculture.*

Figure—Relationship between commercial agriculture and production, income, consumption, and health


Household Level
Cash Crop Production
Agricultural Production
Demand for Hired Labor
Allocation of Household Resources
Income
Time
Household Food Consumption
Child Level
Child Care
Individual Food Consumption
Morbidity
Growth

production, the demand for hired labor, and allocation of resources within the family. A positive effect of commercial agriculture on one of these pathways could be offset by a negative effect on another. By influencing any of the three pathways at the household level, cash cropping can also affect the health and nutritional status of individual family members. Thus the figure serves as a basis for conceptualizing the study and design of the research protocol.

The process through which the commercialization of local agriculture may influence an individual's health and nutritional status is complex. As shown in the figure, an understanding of this process requires linking a series of household factors to individual characteristics and, therefore, involves collection of data from the community, household, and individual household members. Table 1 describes the variables included in the study and the method of data collection.

A variety of techniques including observation, recall, and direct measurement were used in the survey. Enumerators, recruited from the local area, visited the study households bimonthly over an eight-month period beginning in June 1984 and ending in February 1985.

Study Area

The research for this study was conducted in a project area located in Nyanza Province, South Nyanza District, in the southwest part of Kenya. Nyanza Province

Table 1—Data collected in the survey, June 1984 to February 1985

Variables	Round 1	2	3	4	Method	Frequency of Collection/ Period of Recall
Community-level variables						
Food prices	x	x	x	x	Observe	Every two weeks
Nonfood prices	x	x	x	x	Observe	Periodically during the survey
Population				x	Record retrieval	Population statistics collected for 1984
Services available	x	x	x	x	Observe	Periodically during the study
Household-level variables						
Socioeconomic information	x				Recall	Once, at initial visit
Income by source (agricultural, nonfarm, loans, other types)	x	x	x	x	Recall	Round 1 for prior six months; other rounds for the prior two months
Income by individual earner	x	x	x	x	Recall	Same as above
Food expenditures	x	x	x	x	Recall	Each round for prior seven days
Nonfood expenditures	x	x	x	x	Recall	Each round, flexible period of recall for each of the items
Energy consumption	x	x	x	x	Recall	Each round for prior 24 hours
Water (source, distance)	x				Recall	Once, differentiated by rainy and dry season
Sanitation (presence of latrine)	x				Observe	Once, at initial visit
Agricultural production (inputs by crop, production by crop)	x	x	x	x	Recall	Round 1 for prior growing season; other rounds for prior two months
Storage of crops and agricultural inputs	x	x	x	x	Recall	Each round, report on what is in storage at time of visit
Labor input by crop and task, by household (adult and child), and by hired workers	x	x	x	x	Recall	Same as for agricultural production
Women- and child-level variables						
Reproductive history	x	x	x	x	Recall	Once at initial visit, changes (births and deaths) recorded on subsequent rounds
Age	x	x	x	x	Recall	Once, at initial visit
Time allocation	x	x	x	x	Recall	Each round for prior day
Weight, length, and weight-for-length	x	x	x	x	Actual measurement	Each round
Preschooler energy intake	x	x	x	x	Recall by caretaker	Each round for prior 24 hours
Breastfeeding history and weaning practices	x				Recall by mother	Once, at initial visit, recall of birth to age of weaning
Morbidity patterns	x	x	x	x	Recall	Each round for prior two weeks
Mortality	x	x	x	x	Recall	Once, at initial visit, deaths of any children during survey were recorded

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

has historically been a grain-producing area supplying basic staples for other parts of Kenya, but since the early 1970s, it has become part of the sugar belt of Kenya.

In 1977, a new sugar factory was established—the South Nyanza Sugar Factory (SONY). The SONY factory obtained approximately 2,500 hectares of land from local landowners to establish the factory and its nucleus estate. The majority of sugar, however, is produced by smallholders under contract to SONY. The outgrowers' program includes 6,000 contract farmers and approximately 6,000 hectares of land. A more detailed description of the sugar scheme is provided in Chapter 3.

Research Design and Sampling

The sampling frame was constructed to mirror the distribution of types of households found in the community as a whole. At the outset of the study, a list of all farmers ever in the outgrowers' scheme was obtained from SONY. From this list, a random sample of sugar farmers, weighted by sublocation, was chosen.[5] Each of the randomly selected households had to meet the following criteria: first, each had to have at least one preschooler in the household; second, each had to have less than 20 hectares of land; and third, each farmer had to be a resident of the area. The presence of a preschooler in the household was important because the government of Kenya was specifically interested in evaluating the impact of the commercialization of agriculture on the nutritional status of preschoolers.

The sugar farmers represent outgrowers in various stages of the scheme. A contract with SONY normally lasts five years and includes a plant crop and two ratoon crops. The first sugar plantings in the area were done in 1978; farmers who planted in the early years of the outgrowers' program were already on their second contract when fieldwork for the current study began in June 1984.

Because the SONY factory is the newest sugarcane scheme in Kenya, the outgrowers' program is still expanding. Thus it provided the opportunity to identify a cohort of farmers prior to entry into the outgrowers' program or prior to their first sugar harvest and to collect baseline information on sociodemographic characteristics and health and nutritional status.

Of the 181 sugar farmers in the study sample, 77 percent had received at least one payment for a sugar crop. This group is called the sugar farmers. Twenty-three percent of the farmers had not yet had a first harvest and had therefore not received payment for any sugar harvest. This group is called new entrants.

The sample of sugar farmers is heterogeneous, permitting assessment of the short- and longer-term effects of the outgrowers' program by looking at farmers in various stages of the scheme. Once a sugar farmer was chosen for the sample, field staff identified the next nearest nonsugar farmers who met the same selection criteria.[6] This approach ensured geographic similarity of sugar and nonsugar farmers. For each sugar contractor, mapping was performed on comparable households of up to three neighbors of which one or two were randomly selected. The research was concerned with the effect of the sugar scheme on the entire area served by the factory. It was, therefore, important to have a representative sample of all types of households, including nonagricultural households.

In addition to a random sampling of farmers, this research is one of only a few studies that provides community assessment of the range of effects of commercial agriculture. On the premise that some of the most dramatic effects of cash cropping may be on households not directly involved in the scheme—the landless and the merchants—it was deemed important to include a sample of nonagricultural as well as agricultural households in the study.

This community-assessment approach has not typically been done in prior studies. Yet it may be the households not directly involved in cash crop production that are most affected. For example, if the new commercial crop is more labor-intensive than the crop it replaces, landless laborers may benefit the most by the transition from semisubsistence to commercial agriculture. If the opposite is true, landless laborers will be adversely affected. Therefore, landless households were randomly selected by doing a restricted area census of all families without land living in the eight small villages of the project area. Two groups emerged from the general category of "landless." First, there was a group of households who owned no land and who had no permanent source of income. These are the types of households who are generally thought of as landless and who for the purpose of this study are called "landless." The second group of landless were those households who did not own land but who did have a regular source of income. It includes professionals as well as salaried workers. This group was reclassified as "wage earners."

---

[5] A sublocation is the smallest administrative unit in Kenya. The SONY factory serves 25 sublocations. Areas closer to the factory have a higher proportion of sugar farmers than areas further out from SONY. For more detailed information, see Bruce Cogill, "The Effects on Income, Health, and Nutritional Status of Increasing Agricultural Commercialization in South-West Kenya" (Ph.D. thesis, Cornell University, 1987).

[6] Nonsugar households also had to have a preschooler, have less than 20 hectares of land, and be resident owners.

Finally, a mapping was done of all businesses in the main township—Awendo—and the eight villages in the project area. From these lists, a random sample of local merchants was selected.[7] Many of the merchant households were also involved in agriculture; for the present study, however, a household was defined as "merchant" if the major source of household income was supplied by the business activity.

The composition of the study sample is shown in Table 2. Its distribution is similar to the distribution of types of households in the area as a whole. It is estimated that one-third of the approximately 22,000 households in the community are sugar farmers and 80 percent of all households are involved in agriculture.

The average household size for the sample as a whole—9.9 household members—is large because many households are polygamous. Table 3 shows that the nonagricultural households (merchants, wage earners, and landless) have smaller households, on average, than any of the agricultural groups. This is true even for the number of adult equivalents in the household.

As expected, landholdings in the agricultural households are larger than in the nonagricultural groups. The new entrants and both sugar and nonsugar farmer groups have a similar number of hectares per capita.

Table 2—Composition of the sample

Activity Group	Number in Sample	Share of Sample
		(percent)
Agricultural		
New entrants	42	8.3
Sugar farmers	139	27.6
Nonsugar farmers	231	45.8
Nonagricultural		
Merchants	30	6.0
Wage earners	18	3.6
Landless	44	8.7
Total	504	100.0

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Table 3—Characteristics of households in the study sample, 1984/85

Activity Group	Mean Household Size[a]	Number of Adult Equivalents[b]	Percent of Children in Household[c]	Size of Landholding[d]	
				(hectares)	(hectares/capita)
New entrants	9.4	6.2	50.5	5.0	0.59
Sugar farmers	11.1	7.4	52.9	5.6	0.56
Nonsugar farmers	10.2	7.0	52.3	3.7	0.41
Merchants	8.8	5.0	53.0	1.5	0.23
Wage earners	6.6	4.3	50.3	0.5	0.08[e]
Landless	6.6	4.1	52.3	0.4	0.07[e]
Sample mean	9.9	6.6	52.3	3.8	0.41

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Notes: All variables are evaluated at the sample mean. Children are defined as those below 15 years of age.

[a] Sugar and nonsugar farmers have significantly larger households ($p<0.05$) than landless, and sugar farmers have significantly larger households than wage earners ($p<0.05$).

[b] Agricultural households are significantly larger at the 0.05 level than nonagricultural households.

[c] No two groups are significantly different.

[d] Farmers have significantly larger landholdings and more hectares per capita at the 0.05 level than nonagricultural households.

[e] Some of the landless have access to council-owned land.

---

[7] The merchant sample had to meet the same selection criteria as agricultural households.

3

COMPARATIVE ANALYSIS OF MAIZE AND SUGAR CROPPING PATTERNS IN SOUTH NYANZA

Farming Systems Profile

Farming in South Nyanza is dominated by smallholder agriculture with the household providing most of the agricultural labor.[8] Maize is the main staple grown in the project area. All crops are grown under rainfed conditions. There is a bimodal pattern of rainfall with a long rainy season from February to May and a short rainy season from October to December. In 1984 both rainy seasons were delayed by as much as two months.

From 1978 to 1983 rainfall in the project area ranged between 1,515 and 2,032 millimeters with an average for the period of 1,758 millimeters.[9] The research was conducted during 1984, which was a low rainfall period, averaging only 1,202 millimeters for the year. It is important to emphasize that although 1984 was a drought year throughout Kenya, the research area was not severely affected. Rainfall data provided by the Government of Kenya indicate that sufficient rain fell in most of Nyanza province; the total amount of rain was below normal (1,202 millimeters for 1984 versus 1,758 millimeters in a typical year) but still adequate for a good crop.[10] It was the late arrival of the long rain rather than an absolute deficit in rainfall that created a problem. Therefore, although the term *drought* is used throughout the report, in actuality, the situation was one of late arrival and slightly lower rainfall. The reduced rainfall in the area affected agricultural production but not to the extent expected in a drought.

Maize planting for the long-rains growing season is done in February or March, with harvesting in late July or August. Maize planting for the short rains begins in September with a harvest in February.

Table 4 presents a profile of cropping patterns for new entrants, sugar farmers, and nonsugar farmers in the long and short rainy seasons. Although nonsugar farmers often grow some sugar, they have not contracted to sell their sugar to SONY. From these data, nonsugar farmers emerge as having a different cropping pattern from that of sugar farmers. Most notable is the significantly smaller percentage of total farm area devoted to all crops by nonsugar farmers compared to sugar farmers in both seasons. A major part of the difference is due to the growing of sugar under contract, which uses 47.9 percent of total area cropped in the long-rain season.

The larger percentage of land devoted to all crops by sugar farmers is reversed when just food crops are compared. During the long rains, sugar farmers have a significantly smaller share—36 percent—of their land in food crops compared to 52 percent for nonsugar farmers. This pattern is repeated during the short rains. However, given that sugar farmers have larger total landholdings, the absolute amount of land devoted to food crops is almost identical for sugar and nonsugar farmers—2.0 hectares compared with 1.9 hectares.

New entrants, it should be noted, appear to be closer to nonsugar farmers with respect to area under all crops, but when food

---

[8] "Small farm" is defined as less than eight hectares.

[9] South Nyanza Sugar Company, Agronomy Section, Kenya, 1984.

[10] Coty Pinckney and J. K. Muthaka, "A Summary Report on the Food Situation in Kenya," Ministry of Agriculture, Kenya, July 1984 (mimeographed).

Table 4—Land allocated to specific crops by agricultural households, by season, 1984/85

Description	Long-Rain Season			Short-Rain Season		
	New Entrants	Sugar Farmers	Nonsugar Farmers	New Entrants	Sugar Farmers	Nonsugar Farmers
Farm size (hectares)	5.0	5.6	3.7	5.0	5.6	3.7
Mean number of crops	7.4 (3.3)	10.1 (6.9)	8.8 (5.5)	4.2 (1.7)	5.5 (3.0)	5.3 (3.1)
Mean number of plots	5.8 (2.3)	7.5 (4.6)	6.6 (3.8)	3.8 (1.6)	4.8 (2.5)	4.6 (2.6)
Land under all crops (percent)	51.7^{a} (28.2)	66.9^{ab} (28.3)	56.6^{b} (29.0)	54.1^{a} (31.2)	64.7^{ab} (28.4)	45.7^{b} (27.9)
Land under food crops (percent)	36.4^{c} (24.8)	36.0^{b} (23.6)	52.1^{bc} (28.8)	32.9^{c} (24.2)	28.8^{b} (19.7)	45.0^{bc} (27.7)
Percent of cropped area						
Local maize, pure stand	11.9	10.4	24.9	33.3	21.7	55.1
Local maize and beans	3.7	3.2	5.1	1.9	2.4	4.4
Local maize and peanuts	4.2	5.3	8.1	n.a.	n.a.	n.a.
Hybrid maize	11.4	6.1	7.7	9.4	8.7	12.9
Hybrid maize and beans	2.7	2.9	3.1	3.5	1.5	2.7
Hybrid maize and peanuts	2.7	2.9	3.3	n.a.	n.a.	n.a.
Sorghum or millet	10.0	8.4	16.6	0.8	3.3	8.5
Finger millet	0.7	1.0	0.5	1.1	0.0	0.0
Cassava	2.7	3.1	6.0	2.3	1.6	2.9
Tobacco	0.0	0.1	0.2	n.a.	n.a.	n.a.
SONY sugar	45.5	47.9	0.0	43.3	48.9	0.0
Other sugar	0.1	0.0	0.0	n.a.	n.a.	n.a.
Sample size	40	132	231	40	132	231

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Notes: The long-rain season is from February to May; the short-rain season is from October to December. Numbers in parentheses are standard deviations. All variables are evaluated at the sample mean.

Estimates of crop area exclude fallow, pasture, and wooded areas. Multicropped plots are counted once. Only edible crops are included in food crops, although the yield may be sold for cash. Summation of individual crops will be greater than the mean percent of land under food crops because multicropped plots are counted more than once.

Tobacco is only planted during the long rains, and no new sugar plots are planted during the short rains.

[a] The t-test comparison of sugar farmers and new entrants indicates $p<0.05$.

[b] The t-test comparison of sugar farmers and nonsugar farmers indicates $p<0.05$.

[c] The t-test comparison of nonsugar farmers and new entrants indicates $p<0.05$.

crops alone are considered, they have percentages similar to sugar farmers. From this result, it can be deduced that they are actively engaged in cash crop production, although they have not yet received payment for sugar.

When specific crops are examined (Table 4), the greater emphasis on food crops is apparent for nonsugar farmers. More than 50 percent of their cultivated land is under maize in both seasons compared to approximately 30 percent for sugar farmers. Furthermore, nonsugar farmers grow significantly more sorghum, millet, and cassava, crops associated with more traditional diets in the region. Another potentially important factor that may have affected the extent of planting of sorghum, millet, and cassava by more risk-averse nonsugar farmers in 1984 was the early reporting of the severe drought in eastern Africa, although, as already mentioned, the drought turned out to be less severe in South Nyanza.

Maize clearly dominates the cropping pattern for nonsugar farmers. Table 5 summarizes the pure-stand maize production for those households from which data were obtained. The total household farm area de-

Table 5—Production characteristics of local and hybrid maize and sugarcane by agricultural households, long-rain season, 1984/85

Crop Data	New Entrants	Sugar Farmers	Nonsugar Farmers
Local maize[a]			
Sample size	27	102	183
Total area (hectares)	0.4 (0.5)	0.7 (0.7)	0.8 (0.9)
Yield (kilograms per hectare)	962.7 (1,103.0)	864.2 (562.0)	845.2 (661.0)
Amount sold (kilograms per hectare)	101.1 (358.2)	74.1 (189.4)	85.9 (225.4)
Percent of production kept for own consumption[b]	89.5	91.4	89.8
Hybrid maize[a]			
Sample size	19	54	76
Total area (hectares)	0.4 (0.7)	0.4 (0.8)	0.3 (0.5)
Yield (kilograms per hectare)	876.2 (678.4)	990.8 (714.9)	987.5 (949.8)
Amount sold (kilograms per hectare)	124.1 (203.8)	117.4 (318.2)	127.8 (328.9)
Percent of production kept for own consumption[b]	85.8	88.2	87.1
Contracted sugarcane[a]			
Sample size	42	139	232
Total area (hectares)	0.9	1.7	. . .
Yield (tons per hectare)[c]	no harvest yet	106.0	. . .
Amount sold (kilograms per hectare)	. . .	. . .	. . .
Percent of production kept for own consumption	0.0	0.0	0.0

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Note: Maize is grown exclusively in these plots; no intercropped plots are included. The numbers in parentheses are standard deviations.

[a] Plots with single-stand crops tend to be larger than mixed-crop plots. Areas here will differ from those in Table 4.

[b] Some of the crops in storage may be sold at a later date.

[c] The sugarcane yield only includes the plant crop for 1984.

voted to single-stand local and hybrid maize tends to be small, ranging from 0.3 to 0.8 hectare. For sugar farmers, a larger parcel of land, on average, is allocated to the major cash crop, sugarcane. The average area of 1.7 hectares for sugarcane is about two-and-a-half to four times larger than the standard maize area.

What is striking from these data are the similarities in food-crop production among different types of households. Maize yields are lower than would be expected in a normal rainfall year. The shortfall in production can be partly explained by the reduced and badly timed rainfall. Yields are similar for both hybrid and local varieties suggesting little additional advantage in using the purchased hybrid varieties, although it is difficult to know what additional effect the adverse climatic conditions had on the performance of hybrid maize. Most of the maize, both local and hybrid, is kept for home consumption, suggesting that food security is a major household concern.

Adverse climatic conditions are but one reason for low yields. Overall use of inputs is low. Table 6 shows the average utilization of fertilizer per hectare for the major food

Table 6—Fertilizer use by crop, long-rain season, 1984/85

Crop	Total Area Under Production[a]	Area Fertilized		Total Fertilizer Use	Mean Fertilizer Use/Hectare of Total Crop Area	Mean Fertilizer Use/Area Fertilized
	(hectares)		(percent)	(kilograms)	(kilograms/hectare)	
Local maize	298	3	1.0	56	0.18	18.7
Hybrid maize	144	21	14.6	248	1.67	11.8
Sorghum	108	2	1.9	67	0.62	33.5
Peanuts	80	1	1.3	35	0.44	35.0
Tobacco	27	19	70.0	2,038	75.50	108.0
Sugar	251	226	90.0	38,602	154.80	170.8

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

[a] Area is based on estimates for sample households only.

crops and cash crops. The average amount of fertilizer used for local maize is only 0.18 kilogram per hectare; 84 percent of sugar farmers and 94 percent of nonsugar farmers use no inorganic fertilizer for local maize.

The average fertilizer use per hectare is misleading given the large number of farmers who use none at all. As shown in Table 6 for local maize, sorghum, and peanuts, only 1-2 percent of cultivated land receives any fertilizer. Where any fertilizer is used, the mean amount used per hectare of fertilized land is substantially different (12 to 35 kilograms, depending on the crop) from the average amount used on total cropped area (0.18 to 0.62 kilograms, depending on the crop). The percentage of cultivated area that is fertilized is dramatically larger for the two main cash crops: 90 percent of sugarcane and 70 percent of tobacco are fertilized.

Soil quality differences may also influence the yields of various crops. Data from this survey indicate that about 64 percent of plots growing sugarcane are ranked by farmers as good quality soil; this is in contrast to other crops where only 47 percent of the plots are ranked as good.

Labor is the major input used for most crops. As Table 7 shows, labor inputs differ between sugar- and nonsugar-growing

Table 7—Total household labor and hired labor for major crops, long-rain season, 1984/85

Crop	New Entrants		Sugar Farmers		Nonsugar Farmers	
	Household Labor	Hired Labor	Household Labor	Hired Labor	Household Labor	Hired Labor
	(man-days/hectare)					
Local maize	145	4	147	8	148	8
Hybrid maize	164	4	110	22	188	15
Sorghum	109	2	161	5	169	6
Peanuts	215	2	191	7	196	18
Beans	127	1	111	11	147	13
Tobacco	211	2	349	40	419	10
Sugar[a]	109	50	90	32	96	31
Total man-days per hectare (all crops)	1,080	65	1,159	125	1,363	101

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Notes: One man-day equals eight hours. Child labor equals one-half adult labor.

[a] Sugar includes contract and noncontract sugar. It is not restricted to the long-rain period.

households. For local maize, sorghum, and peanuts, the amount of household and hired labor is similar. However, for hybrid maize and tobacco (crops commonly thought of as cash crops), the sugar households consistently use less household and total labor per hectare but about 25 percent more hired labor than nonsugar farmers.

Many of the functions required for sugarcane production are carried out by the factory at a cost to the farmer. The charges for each of these services are listed in Table 8. Weeding and harvesting of the plant crop accounted for 1,516 Kenyan shillings (KSh), most of which was the cost of factory-provided wage labor. At a 1980 wage rate of KSh 12 per day, this amounts to 126 days of hired labor per hectare generated as a result of sugarcane production. Thus the total demand for wage labor by sugar producers is 32 days of labor per hectare hired directly by the farmer and 126 days of occasional labor provided and charged for by the factory. The amount of factory-provided labor implies that wage-earning opportunities for the landless in the area served by the sugar scheme are substantial.

For each of the food crops, the allocation of household labor is much higher than that shown for sugarcane (Table 7). A 24-month plant crop cycle for sugarcane requires about 90 days of household labor. A similar 24-month cycle of four maize crops would require 510 days of household labor. The level of household labor in sugar farming is low due to the mechanized nature of the outgrowers' program. Because many tasks, such as land clearing, planting, and harvesting, are done by the factory, the need for household labor is substantially reduced. If these tasks were not mechanized or not done by the factory, household labor input would have to be about 50 percent higher than it currently is.[11]

Household labor in most cases is not fungible between the sugarcane crop and food crops; women are responsible for many of the tasks involved in producing food crops, whereas men have responsibility for the cash crops.[12] The amount of household, hired, and total labor going into the major food crops is virtually identical across the different agricultural households. Although the study does not have agricultural labor data disaggregated by gender, information was collected on time allocation patterns for women. As shown in Table 9, the amount of time spent in all farming tasks, excluding sugar, is similar for women from sugar and nonsugar-producing households. Moreover, women from sugar-producing households do not, on average, provide much labor for the sugarcane crop.

Sugarcane Production Costs, Yields, and Income

Kenya became self-sufficient in sugar for the first time in 1979. In 1980 and 1981, there was a small exportable surplus of sugar. However, by the mid-1980s, Kenya was again unable to meet the domestic demand for sugar. The current goal of the Kenyan government is to increase sugar production to at least cover domestic needs.

Smallholders are the primary source of sugarcane in Kenya. Small-farmer production of sugarcane increased from 30.2 percent of total supplies in 1976 to 44.4 percent in 1980. It is expected that the prominent role of the small farmer in sugarcane production will continue.

Most of the sugarcane production occurs in the Lake Victoria Basin area in Western and Nyanza provinces. The SONY factory, the newest sugar factory in Kenya, is located in the South Nyanza district of Nyanza Province, and has been in operation since 1978.

When the SONY factory was first built, 2,500 hectares were acquired from local farmers to provide factory-owned land for sugar production. These 2,500 hectares compose what is called the nucleus area of the sugar estate. In addition, the factory has developed an outgrowers' program where

---

[11] For estimates of average labor requirements for mechanized and nonmechanized sugarcane cultivation, see Republic of Kenya, *Soils of Kisii* (Nairobi: Government Printer, 1982).

[12] The one exception is land preparation for food crops, which is typically done by men in the household.

Table 8—Summary of the costs of factory inputs per hectare of sugarcane, by task

Task	Total Sample		Sample Excluding Those Who Had Zero Input Cost	
	Cost	Number of Plots	Cost	Number of Plots
	(Ksh)		(Ksh)	
Clearing land	848	189	1,020	157
Survey	48	188	50	180
Grading	10	184	240	8
Plowing	623	191	657	181
Harrowing	44	175	586	13
Furrowing	154	192	170	174
Intercultivation	50	184	329	28
Seed	1,571	188	1,604	184
Planting	19	184	354	10
Fertilizer				
Plant crop	1,058	177	1,232	152
Ratoon 1	745	87	887	73
Ratoon 2	411	42	785	22
Pesticide				
Plant crop	8	182	306	5
Ratoon 1	19	87	0	. . .
Ratoon 2	0	42	0	. . .
Weeding				
Plant crop	176	183	895	36
Ratoon 1	101	87	516	17
Ratoon 2	327	43	1,004	14
Harvesting				
Plant crop	1,340	174	1,371	170
Ratoon 1	779	85	860	77
Ratoon 2	702	42	757	39
Transportation				
Plant crop	3,942	174	4,132	166
Ratoon 1	2,300	85	2,539	77
Ratoon 2	2,324	42	2,440	40
Administration				
Plant crop	624	174	642	169
Ratoon 1	429	85	480	76
Ratoon 2	388	42	417	39
Interest				
Plant crop	1,110	174	1,143	169
Ratoon 1	282	85	311	77
Ratoon 2	151	43	202	32
Other				
Plant crop	361	178	613	105
Ratoon 1	359	86	630	49
Ratoon 2	112	42	364	13
Total cost of factory inputs per hectare				
Plant crop	12,031	174	. . .	. . .
Ratoon 1	5,030	85	. . .	. . .
Ratoon 2	4,400	42	. . .	. . .

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.
Note: 1980 is used as the base year.

Table 9—Time allocation of women

Women in Activity Group	Hours Away From Home[a]	Weeding[a]	Total Farming Excluding Sugar[a]	Child Care[b]	Sugar[c]
			(hours/day)		
New entrants N = 193	3.7	1.4	3.3	2.0	0.2
Sugar farmers N = 752	3.5	1.1	3.2	1.8	0.2
Nonsugar farmers N = 1,156	3.5	1.3	3.3	1.9	0.0
Merchants N = 106	1.1	0.1	0.7	1.2	0.0
Wage earners N = 62	2.2	0.8	2.1	1.5	0.1
Landless N = 160	2.5	0.5	1.8	1.4	0.2
Sample mean N = 2,429	3.3	1.1	3.0	1.8	0.1

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Notes: Time allocation data are based on recall of time spent on the previous day's activities. Recall was reported a maximum of four times, and all four rounds were averaged. N equals number of observations.

[a] Women in agricultural households spent significantly more time on this activity at the 0.05 level than women in other types of households.

[b] New entrants and nonsugar farmers spent significantly more time on this activity at the 0.05 level than merchants.

[c] Sugar farmers spent significantly more time at the 0.05 level than nonsugar farmers.

farmers produce sugarcane and sell the commodity directly to the factory. Currently, 6,000 hectares are cultivated under the outgrowers' program.

The outgrowers' program at SONY is similar to outgrowers' programs in other sugar schemes throughout Kenya. Farmers are under contract to the factory, which agrees to purchase sugarcane from the outgrowers at the price prevailing at the time of harvest.

The normal cycle for sugarcane in the SONY area involves a plant crop and two ratoon crops. The time between planting and harvest is 22-24 months for the plant crop and 18-19 months for each ratoon.

For a fee, the factory provides a variety of services to the farmer. Typically, the factory will survey the farmland to identify the acreage most suitable for sugarcane production. In addition, the factory may also clear the brush, prepare the land, provide seed and fertilizer, plow, weed, cut the cane, and transport the final crop. The extent to which the factory provides these services varies depending on the individual needs of the farmer and the availability of inputs from the factory. Since 1983, the SONY factory has implemented the "self-development" scheme, which requires the farmer to provide a greater proportion of the crop inputs. For example, new farmers wishing to participate in the outgrowers' program now have to clear the land themselves or have a cleared plot of land available. So, while the factory has historically supplied most of the crop inputs, this pattern has been changing in recent years. The charge for each of the factory-provided services includes an interest charge applied to each service and an administrative levy, which is deducted from the final payment for the sugarcane crop. A description of the cost of factory inputs is provided in Table 8. The overwhelming portion of sugar crop inputs are supplied by the factory at a ratio of approximately 10:1.

Table 10 summarizes cost,[13] yields, and income per hectare for each of the three

---

[13] All cost information is in constant Kenyan shillings using 1980 as a base year.

Table 10—Summary of sugar yield, income, and inputs per hectare, by harvest, 1978-84

Yield/Income/Inputs	Plant Crop	Ratoon 1	Ratoon 2
Yield per hectare (metric tons)	103	63	54
Total cost of factory inputs per hectare (KSh)	12,031	5,030	4,400
Total cost of contract inputs per hectare (KSh)	1,097	519	469
Total number of days of family labor[a]	88	68	83
Total net income per hectare (KSh)	4,316	4,517	4,506
Total net income per hectare per month (KSh)	176	231	237
Ratio of factory inputs to gross returns per hectare	0.74	0.47	0.49
Total net income per hectare per day of family labor (KSh)	49	66	54
Total net income per hectare per estimated days of family labor[b] (KSh)	59	84	83
Sample size (number of plots)	175	86	42

Source: Records provided by the South Nyanza Sugar Company.

Notes: All cost data are in real terms in Kenyan shillings; 1980 is the base year.

[a] The average number of family days is imputed for households with missing labor data.

[b] Number of labor days is based on Government of Kenya labor estimates (see Kenya, *Soils of Kisii* [Nairobi: Government Printer, 1982]).

harvests. The total cost of factory inputs for the plant crop is approximately two-and-one-half times the input charges for the ratoon crops. Two factors account for this dramatic difference in input costs. First, many of the factory charges are on a one-time basis only, land clearing, surveying, grading, plowing, harrowing, furrowing, intercultivation, seed cane, and planting, for example. The cost of these inputs and services are recouped from the first harvest.[14] Second, yields generally decrease between the first, second, and third harvests; thus, the cost of any input that is based on tonnage—such as harvesting or transportation—decreases from the first to the third harvest.

This pattern of decreasing yields is consistent with data from the sugar factory management. For a well-maintained crop, the factory expects to see a 15 percent decrease in yield between plant crop and first ratoon and an additional 15 percent decrease between the first and the second ratoon. The data in Table 10, however, show a 40 percent decrease in yield between the plant crop and the first ratoon—higher than the yield decreases seen on the factory experimental plots. The low yields in the first ratoon crop may be due to a number of factors, including suboptimal use of fertilizer. Yields on the plant crop may not be affected by inadequate fertilizer use, but the yields on ratoons will be substantially less if fertilizer is not applied.[15]

It may seem surprising that farmers use less fertilizer than is optimal given that fertilizer is usually available from the factory. The choice to use it is left entirely up to the farmers, however. In addition, there were periods in late 1983 and 1984 when fertilizer was not readily available from the factory.

---

[14] In some cases, the factory splits the charge for land clearing between the plant crop and first ratoon.

[15] Based on data provided by SONY Factory, Agronomy Section, Kenya, 1985.

The net income per hectare is fairly stable across the three harvests despite the large drop in yields. This is due primarily to the concurrent decrease in total costs of inputs per hectare. The ratio of factory inputs to gross income decreases from 0.74 for the plant crop to 0.47 and 0.49 for the ratoon crops.

The net income per hectare per month of production and the net income per hectare per day of family labor are positive for each of the three harvests. The daily agricultural wage rate in the area during the study period was approximately KSh 16, or KSh 12 in 1980 figures. Data in Table 10 show that the returns to household labor from sugarcane using 1980 shillings are four to five times higher than the daily agricultural wage rate. Similar, although higher, net returns to household labor are obtained if the government's estimate of average family labor for sugarcane production is used.

The data in Table 10 indicate that, on average, sugar farmers are earning a return to family labor that is substantially better than an equivalent time spent as an agricultural wage laborer. However, these aggregate data mask year-to-year variations in yields and income. Table 11 presents input, yield, and income information broken down by year of planting: late 1979 and 1980 were particularly bad periods for planting because of the limited rainfall in the area. These adverse climatic conditions affected yields, which in turn influenced income. The net returns per hectare per day of family labor for 1979 and 1980 were lower than normal but still twice the daily agricultural wage rate. The significant increase in net income between 1980 and 1981 plantings are due to an increase in yield, an increase in the cane price, and a decrease in cost of factory inputs.

The majority of farmers in the outgrowers' program are not experiencing losses; 91.8 percent of the sample received some positive income. However, the percentage of farmers with losses varies by year, with a high of 20 percent for the 1982 harvest and a low of 7 percent for the 1984 harvest. Most farmers in the sample—93.4 percent—remain in the outgrowers' program.[16] Even farmers who have one debit crop usually remain and go on to achieve a positive income from subsequent sugar crops.

There is no significant difference in either yield or income between smaller and larger farmers.[17] The results presented in Table 10 indicate that the net returns per hectare of land and the net returns per hectare per day of family labor are positive and stable across the three harvests. In addition, the net returns to family labor are significantly higher than the daily wage rate for agricultural labor. This may seem surprising given the volatility in the world price of sugar during the period 1979-84. However, the government of Kenya has adopted a protectionist policy with regard to prices paid for sugarcane. Since 1979, there has been a consistent increase in both the nominal and real price paid to smallholders for sugarcane. If the government had used the world price of sugar as a benchmark for establishing the producer cane price, the profitability of sugarcane production in Kenya would be very different. A reanalysis of the data from Table 10 using the average International Sugar Agreement price for 1979-84, shows that in three out of the five years, net returns to land and labor would have been negative. The current sugarcane pricing policy has worked to the advantage of the sugar producer. This is most likely a major reason why 93.4 percent of the study plots planted with sugarcane have remained in the outgrowers' program.

National data suggest that sugarcane is replacing maize on most of the plots that are now in the outgrowers' scheme.[18] Data from the present study support this conclusion; 95.2 percent of the plots now used

---

[16] The random sample of farmers was chosen from contract identification numbers given to farmers upon signing a contract. Some of these farmers dropped out of the scheme.

[17] See Eileen T. Kennedy and Bruce Cogill, "A Sugarcane Outgrowers' Scheme in Kenya: The Case of SONY," International Food Policy Research Institute, Washington, D.C., February 1987 (mimeographed).

[18] Republic of Kenya, *National Food Policy Paper.*

Table 11—Summary of yield and income from sugar, by harvest and by year of planting, 1978-82

Year of Planting	Yield/ Hectare	Number of Plots	Total Net Income/ Hectare	Total Net Income/ Hectare/Day of Family Labor
	(metric tons)			(1980 KSh)
1978				
Harvest 1	112	33	4,005	46
Harvest 2	62	31	4,021	59
Harvest 3	56	26	4,354	52
1979				
Harvest 1	98	28	2,146	24
Harvest 2	67	24	4,724	69
Harvest 3	50	14	4,551	55
1980[a]				
Harvest 1	88	35	2,485	28
Harvest 2	60	29	4,783	70
Harvest 3	57	2	6,185	75
1981				
Harvest 1	109	22	6,376	72
Harvest 2	54	2	5,894	87
Harvest 3	n.a.	n.a.	n.a.	n.a.
1982				
Harvest 1	106	53	5,775	64
Harvest 2	n.a.	n.a.	n.a.	n.a.
Harvest 3	n.a.	n.a.	n.a.	n.a.

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.
Notes: All income is in real terms, using 1980 as a base year. n.a. indicates not available.
[a] 1980 was a drought year.

for sugarcane were planted in maize immediately prior to the outgrowers' scheme. Moreover, 57.1 percent of the study farmers in the outgrowers' scheme indicated that they have decreased the amount of land devoted to food crop production since they joined the program. However, the absolute area planted in food crops is almost identical for sugar and nonsugar producers. While it appears that subsistence production of basic staples has not been affected by sugar production, the amount of marketed surplus, particularly of maize, has probably decreased. This apparent food crop-cash crop trade-off could potentially affect local and national food availability.

Comparative Analysis of Food Crops Versus Sugar

The data on sugarcane yields and returns suggest that sugar production is profitable for the small farmer. Here the net returns to land and labor for alternative crops are analyzed with specific focus on maize because this appears to be the crop competing most heavily with sugarcane.

In Table 12 net returns for maize and sugar are compared. Because the cost data on sugar reflect a multiyear period and were all converted to 1980 figures, all cost information in this section is also presented in 1980 shillings. The sugar crop planted in 1982 and harvested in 1984 is compared to the maize crop harvested in 1984. The total net returns per hectare of land are similar for sugar and maize. However, given the significantly lower household labor input into sugar, the net income per hectare per day of family labor is dramatically higher for sugarcane (KSh 64) than for maize (KSh 10). The returns per day of family labor from sugar are substantially above the daily agricultural wage rate of KSh 12 at the 1980 rate, but for the actual 1984 returns to labor from maize, the opposite is true. The average return per day of family labor is lower

Table 12—Net returns for sugar and local maize, 1984

Income/Labor	Sugar 1982 Planting/ 1984 Harvest	Local Maize Based on 1984 Actual Yield	Based on a Hypothetical Medium Yield
		(KSh 1980)	
Total net income per hectare	5,775	4,988	9,920
Number of days of family labor per hectare for 24 months	90	510	510
Total net income per hectare per day of family labor	64.0	9.8	19.5
Total net income per hectare per month	241	208	413

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Notes: 1980 is used as the base year for all cost calculations for sugar and maize. All cost data are in constant Kenyan shillings, rounded to the nearest shilling.

Income calculations are based on the assumption that there are four maize harvests in a two-year period. Labor days are an average of household labor inputs in the long- and short-rain seasons.

A medium yield is about 2,000 kilograms per hectare.

than the agricultural wage rate. If the returns to labor for a medium-yield harvest are compared, the average return per day of family labor for maize is above the average agricultural wage rate.

The net returns per hectare per month are similar for maize and sugar. This comparison is based on the assumption that during the 24-month period in which the sugarcane plant crop is in the ground, the farmer has the equivalent of four maize harvests.

Because the comparison in Table 12 is somewhat distorted in that a drought maize crop is compared to a nondrought sugar crop, the data are reanalyzed to compare a drought sugar crop (1980 planting year) to the current 1984 drought maize crop (Table 13).[19] The net income per hectare is now substantially less for sugarcane than for maize. However, even with the lower income per hectare for sugar, the returns per day of family labor are still higher for sugarcane than for maize. The returns to household labor for the sugar crop are still above the daily agricultural wage rate and the returns to household labor for sugar are still

Table 13—Net returns for a drought-year sugarcane crop, 1980, compared with a drought-year maize crop, 1984

Income/Labor	Sugar Based on 1980 Planting, 1982 Harvest	Local Maize Based on 1984 Actual Yield
	(KSh 1980)	
Total net income per hectare	2,485	4,988
Number of days of family labor per hectare for 24 months	90	510
Total net income per hectare per day of family labor	27.60	9.80
Total net income per hectare per month	103.50	208.00

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Note: Figures for sugarcane are based on the plant crop only, not on the ratoon crops.

---

[19] Drought will have the most disastrous effects on sugar in the early months after planting.

three times higher than for maize.

Because sugarcane production data are available for 1980-84, it is possible to capture the interyear variation in yields and incomes. In order to capture the same interyear variation in maize returns, maize is analyzed for the period 1980-84 (Table 14). Given the climatic conditions, it is assumed that yields per hectare were average (2,000 kilograms per hectare) for 1981-83 and low for 1980 and 1984.[20]

The analysis presented thus far has been based on the official producer prices of the government of Kenya. Much of the maize in the project area is traded in small quantities and sold for the prevailing market price. Table 14 also compares the official trading price to the high, low, and average trading prices in the local market. The local market price data were collected as a routine part of the survey every two weeks for the period June 1984 to March 1985 and deflated to 1980 prices. Not surprisingly, given that 1984 was a drought year, there is a fair degree of volatility in the average trading price in the local market (more than a twofold difference between high and low maize prices for 1984).

Table 14 also reexamines the gross margins using local market prices. In contrast to Table 12, if all the maize produced by the household were traded at the average market price, the net return per hectare for maize would be higher than for sugar. This finding is somewhat unusual. In many parts of the world, returns to land for sugar are substantially higher than for maize. Two factors account for the superior profitability of maize per hectare compared to sugarcane. First, the growing period for sugarcane is long, averaging 22-24 months for the plant crop and 18-19 months for the ratoon crops. Second, the bimodal pattern of distribution of rain makes it possible to have two maize harvests during a 12-month period. These two factors combine to make returns per hectare for maize quite attractive in the project area. However, the returns per household day of labor are still superior for sugar compared to maize for the multiyear period.

The analyses presented in Tables 12 to 14 are fairly robust. Regardless of whether sugarcane is compared to actual maize yields for 1984, a five-year average for 1980-84, or a drought year for maize, returns to household labor are in all cases substantially

Table 14—Comparison of returns to land and household labor for maize and sugarcane, 1980-84

		Maize, 1980-84[a]			
Returns	Sugar 1980-84	Official Price	Unofficial Price		
			Low	High	Average
Average net income per hectare (KSh)	4,648[b]	7,996	7,738	19,989	11,606
Number of days of family labor per hectare	90	510	510	510	510
Net income per hectare per day of household labor (KSh)	52	16	15	39	23
Total net income per month (KSh)	194	333	322	833	484

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.
Notes: All income calculations are converted to 1980 shillings and rounded to the nearest shilling.
[a]Maize figures are based on average yields of 2,000 kilograms per hectare for 1981-83 and on low yields for 1980 and 1984.
[b]This is the weighted average of plant and ratoon crops for 1980-84.

---

[20] 1984 actual production data were used to reflect low yields per hectare. Average yield estimates for maize were based on government of Kenya data. These yield estimates may overstate actual maize yields in nondrought years.

higher than those for maize. Similarly, for maize, regardless of the method of analysis, returns to land are greater than or equal to returns to land for sugar.

At this time in South Nyanza, labor is more of a constraint to production than land. Presumably households will want to optimize returns per day of family labor. In this respect sugarcane production is quite attractive. In the longer term, with current rates of population growth and migration into the area, land may become more constrained. Returns to land for cropping alternatives will then be more important.

4

INCOME AND EXPENDITURE

Proponents of a strategy advocating the commercialization of agriculture have assumed that incomes of farmers would increase if they switched all or part of their land to cash crop production. Although higher income is only one of a series of household objectives, it is clearly an important one. This chapter examines the effects of sugarcane production on income and expenditure patterns.

Table 15 shows the distribution of income and total expenditures per capita among the study households. Keeping in mind that 1984 was a year with lower rainfall than normal, incomes of households in the community may also be lower. One would expect, however, that agricultural households—sugar- and nonsugar-producing—would have been affected equally by the poor climatic conditions. Moreover, the main interest in this study is the comparison of relative incomes across groups; lower-than-usual absolute incomes are not a major concern for the comparison.

Sugar farmers have significantly higher incomes per capita than either nonsugar farmers or the landless. Since the new entrants to the sugar scheme have yet to receive payment for a sugar crop, their incomes per capita are similar to those of nonsugar farmers.

A similar pattern emerges for most groups when total expenditures per capita are used as a proxy for income. Expenditures per capita are higher (although not significantly so) for sugar farmers compared with new entrants or the nonsugar-growing households. However, there is a marked difference—almost twofold—between income per capita and expenditure per capita for the merchant households. This implies a gross underreporting of incomes by the merchant group, which is not surprising given that merchants' nonagricultural income is likely to be taxed. There is, therefore, an incentive to underreport actual income. The same may be true for landless households with a high proportion of wage income.

Table 16 presents a breakdown of income per capita by source. There are several items to note: first, all of the agricultural households have significantly higher in-

Table 15—Total annual income and expenditures per capita, by activity group, 1984/85

Activity Group	Mean Income	Mean Total Expenditures	Sample Size
		(KSh)	
New entrants	1,956	2,454	42
Farmers with sugar income	2,591[a]	2,756	139
Nonsugar farmers	1,924	2,595	231
Merchant	2,209	4,177[b]	29
Wage earners	2,037	2,183	18
Landless	1,290	1,963	43
Total sample mean	2,077	2,648	502

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Notes: Total income includes marketed agricultural income, agricultural production used for own consumption, and nonfarm income. Total expenditures include all expenditures on food (purchased and home produced) and on nonfood items. KSh 16 = U.S. $1.00.

[a] Farmers with sugar income have significantly higher income than nonsugar farmers and landless at the 0.05 level.

[b] Merchants have significantly higher expenditures than any other group at the 0.05 level.

Table 16—Mean annual income per capita per year, by source for activity groups, 1984/85

Activity Group	Agricultural Income Per Capita				Nonagricultural Income		Percent of Female-Controlled Income	Sample Size
	Used for Own Consumption		Marketed					
	(KSh)	(percent)	(KSh)	(percent)	(KSh)	(percent)		
New entrants	728[a]	37	404	21	824	42	56.5[d]	42
Sugar farmers	748[a]	29	942[b]	36	901	35	50.5	139
Nonsugar farmers	822[a]	43	393	20	709	37	58.5[d]	231
Merchants	51	2	17	1	2,141[c]	97	12.8	29
Wage earners	171	8	45	2	1,821[c]	90	18.6	18
Landless	163	13	48	4	1,079	83	37.7	43
Total sample mean	669	32	482	23	926	45	50.4	502

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Note: KSh 16 = U.S. $1.00.

[a] All agricultural households have significantly higher income per capita from agricultural production used for own consumption than other household groups at the 0.05 level.

[b] Sugar farmers have significantly higher marketed agricultural income per capita than all other groups at the 0.05 level.

[c] Merchants and wage earners have significantly higher nonfarm income per capita than other groups at the 0.05 level.

[d] Nonsugar farmers have significantly more female-controlled income than all other groups except new entrants; all agricultural households have a greater percentage than nonagricultural households. Female-controlled income includes nonfarm income and all agricultural income controlled by women, including the estimated value of household food consumption from own production.

come from production used for own consumption than merchant, wage earner, or landless households. A long-standing criticism of commercial agriculture has been that the amount of food available for home consumption is drastically decreased when households become cash crop producers. The data in Table 16 suggest this is not true. The income per capita used for own consumption is remarkably similar among the different types of agricultural households.

Income from agricultural sales is significantly higher for sugar farmers than for either the nonsugar or the new entrant households. The agricultural sales income per capita for sugar farmers is two to two-and-a-half times higher than that of nonsugar farmers. Much of this difference is due to the income from sugar production; KSh 400 out of KSh 942, or approximately 42 percent, of marketed farm income is contributed by sugarcane.

To present this in another way, sugar farmers earn approximately KSh 550 per capita more from commercial agricultural income than nonsugar farmers; of this amount, 73 percent is contributed by sugar. Sugar income makes a substantial contribution to household income.

Income from marketed surplus is similar for the new entrants and nonsugar farmers. Nonsugar farmers have agricultural sales income per capita of 20 percent, and new entrants, 21 percent. In contrast, 36 percent of total income of sugar farmers comes from agricultural sales.

Data from Table 16 show that the percentage of income controlled by women is significantly less ($p < 0.05$) in sugar-producing than in nonsugar-producing households. However, given that total household income is higher for sugar producers, women from sugar-growing households control a higher absolute amount of income than women from nonsugar-producing households. All women in agricultural households—whether sugar- or nonsugar-producing—control a significantly ($p < 0.05$) higher percentage of income than women from nonagricultural households.

Table 17—Annual food and nonfood expenditures per capita, by activity group, 1984/85

Activity Group	Nonfood		Food	
	Expenditure[a]	Average Budget Share[b]	Purchased Plus Own Production[c]	Average Budget Share[b]
	(KSh/capita)	(percent)	(KSh/capita)	(percent)
New entrants	883	36	1,571	64
Sugar farmers	1,166	42	1,590	58
Nonsugar farmers	953	37	1,642	63
Merchants	2,824	68	1,353	32
Wage earners	925	42	1,258	58
Landless	736	37	1,227	63
Sample mean	1,094	41	1,556	59

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

[a] Merchants have significantly higher nonfood expenditures than all other groups at the 0.05 level.

[b] Average budget shares are a percentage of total expenditures.

[c] No two groups are significantly different.

Table 17 presents a breakdown of expenditures per capita and average budget shares devoted to food and nonfood. It shows no significant differences in the mean amounts per capita spent on food among the different groups. At 32 percent, the average budget share allocated to food is lowest for the merchants. Nonsugar farmers and new entrant households allocate approximately the same amount of their overall budget to food, and sugar farmers allocate a slightly smaller percentage (58 percent) to food than other agricultural households (about 63 percent).

In Table 18 food expenditures are disaggregated by food purchased versus food consumed from own production. Agricultural households, whether sugar- or nonsugar-producing, allocate approximately the same proportion to food purchases. The merchants, the wage earners, and the landless obviously allocate a greater proportion of their food budget to food purchases because they have less land (or, in some cases, no land) on which to grow food.

When per capita food expenditures are broken down into major food groups, mean expenditures per capita are similar among

Table 18—Annual expenditures on and shares of purchased versus own-produced food, by activity group, 1984/85

Activity Group	Food Purchased		Own Production of Food	
	Cost	Percent	Cost	Percent
	(KSh/capita/year)		(KSh/capita/year)	
New entrants	843	54	728	46
Sugar farmers	843	53	747	47
Nonsugar farmers	820	50	822	50
Merchants	1,302	96	51	4
Wage earners	1,087	86	171	14
Landless	1,065	87	162	13
Sample mean	887	57	669	43

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Note: Purchased and own-produced food expenditures are given as a percentage of total food expenditures.

Table 19—Total food expenditures per capita per year and average budget share, by major food group, 1984/85

Major Groups	New Entrants	Sugar Farmers	Nonsugar Farmers	Merchants	Wage Earners	Landless	Mean
				(KSh/capita/year)			
Cereals and grains							
Expenditures	505.0	478.0	502.0	418.0	459.0	459.0	485.0
Mean budget share	20.6	17.4	19.3	10.0	21.0	23.0	18.3
Roots and tubers							
Expenditures	111.0	133.0	142.0	30.0	66.0	56.0	120.0
Mean budget share	4.5	4.8	5.6	0.7	3.0	2.9	4.5
Pulses							
Expenditures	100.0	106.0	91.0	27.0	29.0	28.0	84.0
Mean budget share	4.1	3.9	3.5	0.7	1.3	1.4	3.2
Vegetables							
Expenditures	126.0	137.0	153.0	119.0	120.0	117.0	140.0
Mean budget share	5.1	5.0	5.9	2.9	5.5	5.9	5.3
Fruits							
Expenditures	106.0	73.0	75.0	24.0	37.0	56.0	71.0
Mean budget share	4.3	2.7	2.9	0.6	1.7	2.9	2.7
Fish							
Expenditures	91.0	97.0	97.0	85.0	91.0	97.0	96.0
Mean budget share	3.7	3.5	3.7	2.0	4.2	4.9	3.6
Meat							
Expenditures	128.0	126.0	124.0	172.0	118.0	111.0	126.0
Mean budget share	5.2	4.6	4.8	4.0	5.4	5.7	4.8
Milk/dairy							
Expenditures	108.0	109.0	103.0	159.0	86.0	103.0	108.0
Mean budget share	4.4	3.9	3.9	3.8	3.9	5.2	4.1
Fats and oils							
Expenditures	84.0	83.0	72.0	104.0	69.0	75.0	78.0
Mean budget share	3.4	3.0	2.8	2.5	3.2	3.8	2.9
Sugar							
Expenditures	115.0	107.0	104.0	101.0	117.0	101.0	105.0
Mean budget share	4.7	3.9	4.0	2.4	5.4	5.1	3.9

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.
Notes: Not all food groups are included. Food expenditures per capita are rounded to the nearest shilling. Average budget shares are a percentage of total expenditures.

all types of households for most food groups (Table 19). There are exceptions, however. The landless spent a larger share of total food expenditures on cereals and grains than other households, and merchants a smaller share.

The distribution of nonfood expenditures per capita among major nonfood budget categories is shown in Table 20. As with food expenditures, the average budget share allocated to the different nonfood expenditure groups are similar for most items, but there are some exceptions. Merchants and sugar-producing households spent a greater absolute amount and a greater share of income on housing and education.

The expenditure data presented for sugar farmers in Table 20 are corroborated by other qualitative data on expenditures. Farmers who had completed a first contract were asked to identify the major expenditure categories for which sugar income was used. Farmers were most likely to spend income from both the first and second sugar harvests first on housing, then on school fees.

The discussion thus far has focused primarily on the differences in income and expenditures among different types of agricultural households. However, nonagricultural households may also be affected by the existence of the sugar scheme. The data

Table 20—Nonfood expenditures per capita per year for major categories, by activity group, 1984/85

Nonfood Budget Items	New Entrants	Sugar Farmers	Nonsugar Farmers	Merchants	Wage Earners	Landless
			(KSh/capita/year)			
Housing						
Expenditures	31.0	135.0	39.0	617.0	56.0	63.0
Mean budget share	1.3	4.9	1.5	14.8	2.6	3.2
Fuel and light						
Expenditures	80.0	90.0	98.0	202.0	161.0	164.0
Mean budget share	3.3	3.3	3.8	4.8	7.4	8.4
Clothes						
Expenditures	127.0	163.0	132.0	224.0	187.0	102.0
Mean budget share	5.2	5.9	5.1	5.4	8.6	5.2
Supplies and household goods						
Expenditures	76.0	94.0	73.0	70.0	69.0	76.0
Mean budget share	3.1	3.4	2.8	1.7	3.2	3.9
Health expenses						
Expenditures	49.0	56.0	137.0	97.0	24.0	37.0
Mean budget share	2.0	2.0	5.3	2.3	1.1	1.9
Public transport						
Expenditures	54.0	117.0	70.0	178.0	58.0	59.0
Mean budget share	2.2	4.3	2.7	4.3	2.7	3.0
Bicycles						
Expenditures	88.0	9.0	27.0	468.0	123.0	2.0
Mean budget share	3.6	0.3	1.0	11.2	5.6	<0.1
Education						
Expenditures	71.0	93.0	70.0	145.0	67.0	43.0
Mean budget share	2.9	3.4	2.7	3.5	3.1	2.2
Family events						
Expenditures	26.0	35.0	38.0	66.0	13.0	36.0
Mean budget share	1.1	1.3	1.5	1.6	0.6	1.8
Land bought and rented						
Expenditures	7.0	5.0	4.0	1.0	0.0	0.0
Mean budget share	0.3	0.2	0.2	<0.1	0.0	0.0
Livestock						
Expenditures	47.0	18.0	14.0	<1.0	<1.0	3.0
Mean budget share	1.9	0.7	0.5	0.0	0.0	0.2

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.
Notes: Figures are rounded to the nearest shilling. Not all expenditure categories and savings are included. Average budget shares are a percentage of total expenditures.

presented indicate that sugar farmers have a higher propensity to spend on nonfood items than nonsugar households. This translates into a demand for a different mix of goods and services and has an effect on merchants. Although this cannot be quantified from data collected in this study, there is some indirect evidence that creation of the sugar estate has had a positive impact on the merchant group.

A survey of merchants indicates that 69 percent started their business after the sugar factory was built. Although this finding does not indicate causality, there is an association between the outgrowers' scheme and development of increased trading in the area. Two components of the sugar scheme contribute to the growth of the trading class. The first has already been mentioned—sugar farmers spent 42 percent of their total expenditures on nonfood items. Second, the establishment of the factory also created a more extensive rural infrastructure. Electricity became readily available in the local township and new roads were built. This allowed households within the catchment area that historically had been isolated to have access to goods and services.

It is interesting to note that 41.3 percent of the merchants were farmers or employees of other businesses before becoming traders. About 45 percent of merchants employ two or more employees, indicating that laborers may also benefit from the linkage effects of commercialization through increased employment generation. Moreover, a sense of optimism seems to prevail among this new merchant group; 92.9 percent responded that they anticipated expanding their businesses.

5

THE EFFECT OF COMMERCIAL AGRICULTURE ON ENERGY CONSUMPTION PATTERNS

Income is one of the major determinants of family food consumption. In general, as income increases at least a part of the incremental earnings are spent on food. Given the differences in expenditures and income noted in Chapter 4, one would expect that sugarcane production would have a positive effect on the energy intake of a family.

In Table 21, which shows the energy intake per capita for each of the activity groups by season, however, there is no significant difference among the groups for any of the seasons. The caloric intake per capita is almost identical for the pre- and postharvest seasons.[21] Ordinarily one would expect to see an increase in energy intake in the postharvest season, but because yields for maize and other food crops were below average for 1984, stored grain was reduced and home consumption and market supplies were affected.

Calculation of calories per capita is somewhat misleading because it does not take into account the sex and age composition of different types of households. A more appropriate indicator of energy intake is calories per adult equivalent, which incorporates the specific caloric requirements for each age and sex into the calculation.[22] When the energy intake per adult equivalent is calculated (Table 22), calories are approximately 35 percent higher than when expressed as calories per capita. Here again, there are no significant differences in energy intake among any of the different types of households.

Table 21—Household energy intake per capita, by activity group and season, 1984/85

Activity Group	Season			All-Season Average[b]
	Pre-Harvest	Post-Harvest	Harvesting/ Post-Harvesting[a]	
	(kilocalories/capita/day)			
New entrants	1,778	1,798	1,934	1,869
Sugar farmers	1,711	1,639	1,666	1,707
Nonsugar farmers	1,631	1,592	1,844	1,706
Merchants	1,448	1,539	1,627	1,488
Wage earners	1,800	1,984	1,794	1,961
Landless	1,481	1,665	1,643	1,567
Total sample mean	1,645	1,638	1,771	1,703

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.
Note: No two groups are significantly different at the 0.05 level.

[a] This round took place from December 1984 to February 1985 and thus spans both a harvesting and postharvesting period.

[b] To determine the all-season average, an average for each household is derived from one to three 24-hour household dietary recalls. The overall average for each household is used to compute a mean for the activity group.

---

[21] In this report, all references to calories or caloric intake refer to kilocalories.

[22] Adult equivalent calculations are based on the kilocalorie requirements of an adult male of 2,850.

Table 22—Household energy intake per adult equivalent unit, by activity group and season, 1984/85

	Season			
Activity Group	Pre-Harvest	Post-Harvest	Harvesting/ Post-Harvesting[a]	All-Season Average[b]
		(kilocalories/adult equivalent unit/day)		
New entrants	2,745	2,561	2,932	2,822
Sugar farmers	2,627	2,690	2,646	2,689
Nonsugar farmers	2,524	2,602	2,814	2,669
Merchants	2,241	2,394	2,548	2,281
Wage earners	2,791	2,645	2,835	2,898
Landless	2,338	2,672	2,559	2,506
Total sample mean	2,544	2,620	2,740	2,657

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Notes: No two groups are significantly different at the 0.05 level. The adult equivalent unit is a method used to convert consumption by persons of different ages and sex to standard consumption units. The standard for an adult male equivalent is 2,850 kilocalories.

[a] This round took place from December 1984 to February 1985 and thus spans both a harvesting and postharvesting period.

[b] To determine the all-season average, an average for each household is derived from one to three 24-hour household dietary recalls. The overall average for each household is used to compute the mean for the activity group.

Table 23 shows the average energy intake as a percent of the requirements by season for each of the activity groups. The overall adequacy for calories per adult equivalent for the total sample increased slightly from 89 percent to 92 percent between the pre- and postharvest periods. The lack of a larger effect is due to the drought conditions in Kenya during this period. The increase between the preharvest period and the later harvesting/postharvest season is closer to what would ordinarily be expected: caloric adequacy changed from 89 to 96 percent. For the nonsugar farmers, caloric adequacy

Table 23—Percentage of energy adequacy per adult equivalent unit, by activity group and season, 1984/85

	Season			
Activity Group	Pre-Harvest	Post-Harvest	Harvesting/ Post-Harvesting[a]	All-Season Average[b]
			(percent)	
New entrants	96.3	89.9	102.8	99.0
Sugar farmers	92.2	94.4	92.8	94.4
Nonsugar farmers	88.5	91.3	98.7	93.6
Merchants	78.6	84.0	89.4	80.0
Wage earners	97.9	92.8	99.5	101.7
Landless	82.0	93.8	89.8	87.9
Total sample mean	89.3	91.9	96.1	93.2

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Note: An energy standard of 2,850 kilocalories per adult equivalent unit is used. The adult equivalent unit is a method used to convert the consumption of persons of different ages and sex to standard consumption units.

[a] This round took place from December 1984 to February 1985 and thus spans both a harvesting and postharvesting period.

[b] To determine the all-season average, an average for each household is derived from one to three 24-hour household dietary recalls. The overall average for each household is used to compute the mean for the activity group.

steadily improved from 89 percent to 99 percent over the three time periods. The all-season average for caloric adequacy is almost identical for sugar and nonsugar households.

The mean adequacy levels presented in Table 23 mask the level of energy deficits found within the groups. Table 24 shows the percentage of households within each of the activity groups that are below 80 percent of caloric adequacy per adult equivalent. On average, from 33 to 41 percent of the sample households in any given round are below 80 percent of energy requirements. Caloric deficits are most prevalent in the preharvest period. The percentage of nonsugar farmers below 80 percent of adequacy decreases over time, but the percentage of deficit sugar farmers increases from 34 to 39 percent.

It is curious that the merchant group, which has the highest expenditure per capita, has 62.5 percent of its households below 80 percent of caloric adequacy in the preharvest season. The landless and the wage earners have a smaller percentage of households below the standard, even though both their average incomes and expenditures are smaller than those in the merchant group. Although the low energy intakes of the merchant households may indicate a true caloric deficit, an alternative explanation is plausible. The activity patterns of merchant household members may be dramatically different from those of agricultural households. There is some indication from the time allocation data presented in Chapter 3 that women from merchant households are less physically active; for example, merchant women spend significantly less time in energy-intensive tasks like weeding and other farm activities (see Table 9). Although time allocation data were not collected for all family members, it is reasonable to speculate that merchants have more sedentary lifestyles and thus reduced energy needs. The lower energy-intake levels reflected in Tables 23 and 24 may not signify a true caloric deficiency.

Protein intake in the population on average is above requirements (Table 25). Calories appear to be more limiting than protein.

The energy intake of preschoolers is also assessed, but analyses are complicated by two factors. First, many children, particularly those in the 6- to 12-month age category, obtain a substantial amount of their energy intake from breast milk. Because it was not possible to quantify the caloric contribution of breast milk, children who were receiving any breast milk were eliminated from the dietary analyses.

Second, it is usual for preschoolers to be fed from a common family dish. In these cases, the mothers or caretakers were un-

Table 24—Percentage of energy-deficient households, by activity group and season, 1984/85

	Households Below 80 Percent of Energy Requirements		
Activity Group	Pre-Harvest	Post-Harvest	Harvesting/ Post-Harvesting[a]
		(percent)	
New entrants	43.8	42.9	25.8
Sugar farmers	33.6	35.6	38.5
Nonsugar farmers	43.3	40.1	32.1
Merchants	62.5	52.9	40.0
Wage earners	27.3	33.3	20.0
Landless	44.1	42.3	33.3
Total sample mean	41.5	39.7	33.5

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.
Note: An energy standard of 2,850 kilocalories per adult equivalent unit is used.
[a] This round took place from December 1984 to February 1985 and thus spans both a harvesting and postharvesting period.

Table 25—Protein intake per adult equivalent unit, by activity group and season, 1984/85

Activity Group	Protein/Adult Equivalent Unit Pre-Harvest	Post-Harvest	Harvesting/ Post-Harvesting[a]	All-Season Average[b]
		(grams)		
New entrants	98.6	93.4	104.3	100.6
Sugar farmers	99.8	99.1	106.3	101.0
Nonsugar farmers	89.8	94.8	102.9	95.8
Merchants	77.5	100.5	83.0	78.9
Wage earners	142.5	83.5	95.4	115.0
Landless	93.2	87.7	112.4	99.2
Total sample mean	94.6	95.4	102.9	97.5

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Notes: The adult equivalent unit is a method used to convert consumption by persons of different ages and sex to standard consumption units.

[a] This round took place from December 1984 to February 1985 and thus spans a harvesting and postharvesting period.

[b] To determine the all-season average, an average for each household is derived from one to three 24-hour household dietary recalls. The overall average for each household is used to compute the mean for the activity group.

able to quantify the amount of food eaten by the child at a particular meal. Because dietary data for this group of children were "incomplete," energy consumption is probably underestimated. Although the problem of missing dietary data was equally distributed among preschoolers from various types of households, data for preschoolers' energy intake are presented separately for children with complete data and those who ate from the family pot and therefore have missing data (Table 26).

Table 26 presents data on average energy intakes and the percentage of the requirements consumed by preschoolers. For children with complete data, the highest energy intake, as well as the highest caloric adequacy, is for preschoolers from sugar-producing households. During the survey, the average caloric intake of these preschoolers was significantly higher than that of children from nonsugar farmer or landless households. The same pattern is seen for the larger sample, but these differences are not significant. The findings on children's energy patterns are in contrast to those seen for households. Household energy intake was similar across groups, but data indicate that preschoolers from sugar-producing households do better, and in some cases significantly better, than children from other types of households.

Determinants of Household Food Consumption

The analysis of energy consumption thus far has been a static comparison across groups. This descriptive analysis does not allow identification of the determinants of household caloric consumption.

The following model is used to predict household energy intake:

Cal_j = f(Income, Adult Equivalent, Women's Income, Sugar Income, Mother's Schooling, HOH Schooling, Maize Price, Round 2, Round 3, Round 4),

where

Cal_j = calorie intake of household j as measured by 24-hour recall,

Income = total household annual income in KSh,

Adult Equivalent = number of adult equivalent units,

Women's Income = women's income as a percentage of total income,

Sugar Income = income from the sugarcane scheme as a percentage of total income,

Table 26—Energy intake of preschoolers and percentage of requirements met, by activity group, 1984

	Preschoolers with Complete Data			Preschoolers with Meals from Family Pot[a]		
Activity Group	All Rounds	All Rounds	Percent of Requirements Met	All Rounds	All Rounds	Percent of Requirements Met
	(kilocalories)	(kilocalories/kilogram of body weight)		(kilocalories)	(kilocalories/kilogram of body weight)	
New entrants	791 (445)	63 (33)	64 (34)	628 (380)	53 (29)	55 (29)
Sugar farmers	837[b] (398)	67[c] (37)	69[d] (37)	676[e] (393)	54[c] (35)	56[d] (36)
Nonsugar farmers	716 (358)	58 (32)	58 (30)	631[e] (371)	52 (34)	52 (34)
Merchants	598 (295)	46 (23)	47 (23)	471 (281)	39 (26)	39 (26)
Wage earners	586 (307)	50 (23)	49 (24)	469 (294)	42 (26)	42 (26)
Landless	542 (501)	43 (36)	46 (36)	465 (295)	39 (25)	39 (25)
Sample mean	735 (340)	59 (34)	60 (33)	620 (373)	51 (33)	52 (33)
Sample size	655			1,027		

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Notes: Numbers in parentheses are standard deviations.

[a] Because these children ate from a family pot, the number of kilocalories consumed is probably an underestimate.

[b] Preschoolers from sugar-growing households had higher energy intakes at the 0.05 level of significance than those from landless or nonsugar-growing households.

[c] Preschoolers from sugar-growing households had higher energy intake per kilogram consumed at the 0.05 level of significance than those from landless households.

[d] The percentage of preschoolers from sugar-growing households who met nutritional requirements was higher at the 0.05 level of significance than those of landless or merchant households.

[e] Preschoolers from both sugar- and nonsugar-growing farm households had higher energy intakes at the 0.05 level of significance than those from landless households.

Mother's Schooling = education of all women in the household averaged in years,
HOH Schooling = education of the head of household (in years),
Maize Price = maize price (in KSh) at time of 24-hour recall,
Round 2 = round dummy, 1 for round 2, 0 for other rounds,
Round 3 = round dummy, 1 for round 3, 0 for all other rounds, and
Round 4 = round dummy, 1 for round 4, 0 for all other rounds.

This household consumption function was run for the total sample and for agricultural households alone. The results are presented in Table 27.

As expected, the number of adult equivalents is positively and significantly associated with household energy intake. Income also has a positive and significant—but small—effect on energy intake. The marginal propensity to consume calories is quite low. For the total sample, for each KSh 100 increase in income, household energy intake increases by only 3 calories; for the agricultural households, the effect is even smaller with a 2-calorie increase per KSh 100 increase in income.

Table 27—Regression of daily intake of household kilocalories for the total sample and for agricultural households alone

Variable	Total Sample	Agricultural Households Only
	(β)	
Income	0.03 (3.54)	0.02 (2.60)
Sugar income (percent)	23.80 (2.60)	15.50 (1.60)
Women's income (percent)	8.40 (1.60)	−1.60 (−0.24)
Adult equivalent units	1,543.00 (36.80)	1,508.00 (32.70)
Maize price	161.50 (0.55)	365.80 (1.10)
HOH's schooling	143.60 (3.10)	134.70 (2.60)
Mother's schooling	49.40 (0.90)	106.70 (1.70)
Round 2	135.40 (0.28)	53.30 (0.098)
Round 3	887.00 (2.00)	957.90 (1.90)
Round 4	1,676.50 (3.40)	1,944.70 (3.50)
Constant	2,819 (2.79)	3,512 (2.99)
R^2	0.534	0.510
DF	1,434	1,190
F	164.3	125.9

Notes: The numbers in parentheses are t-statistics. When the regression was respecified using income and income squared, the results were similar. HOH is the head of household.

Data in Table 15 showed that total household income in the sugar-producing households that have received payment was approximately KSh 670 per capita per year higher than incomes in households not producing sugar. This incremental income could account for an increase in household energy intake of approximately 200 calories per day or 27 calories per adult equivalent.

Some of the other income-related variables also appear to be important in influencing energy intake. Women's income has a marginally significant ($p<0.10$) effect on household energy intake. For each 1 percent increase in women's income, household consumption would increase by 8 calories—a very small net effect.

The percentage of income earned from sugar production is also significantly associated with household energy intake. This effect is above and beyond what is mediated by total household income. A 1 percent increase in sugar income increases household calorie consumption by 24 calories a day. For sugar farmers in the sample who have received payment, the sugar crop contributed an average of 15 percent to total household income. This 15 percent could add about 360 calories per day to household calorie consumption or approximately 33 calories per person in the household.

There is a seasonal effect, as indicated by variances between survey rounds. Household caloric consumption was significantly higher in rounds 3 and 4, the postharvest seasons, compared with round 1, the preharvest season.

The head of household's schooling also has a positive effect on household energy intake. For each additional year of education, household consumption is increased by 143 calories.

6

MORBIDITY PATTERNS OF WOMEN AND CHILDREN

The sugarcane scheme is one form of development assistance that was targeted to South Nyanza District with the expectation that the economic growth generated as a result of the outgrowers program would result in improved health and well-being for small-farm households. Results from Chapters 4 and 5 indicate that incomes and food consumption have improved as a result of participation in the outgrowers program. This chapter examines the effects of the increased income and improved household caloric consumption on the morbidity patterns of women and children.

Descriptive Analysis

The majority of children and women included in the study were ill in each round. For both women and children, morbidity tends to be highest in round 1, which is the preharvest, rainy period typically associated with more illness. Malaria is most prevalent during this period.

Table 28 presents data on morbidity patterns combined for all rounds. There is no significant difference among groups in the total percentage of time ill in general or with diarrhea during the survey period. What is clear is that the total number of days lost to illness is very high—27 percent—for all groups; the average woman and child is ill approximately one out of every four days.

Next, the morbidity data for preschoolers and women are analyzed by per capita income quartile (Table 29). For preschoolers, there is no significant difference across income quartiles for either the total time ill or the amount of time ill with diarrhea. For women, there is no difference in the total percentage of time ill across income quartiles, but, curiously, women in the two lowest income quartiles have a significantly smaller percentage of time ill with diarrhea than women in the upper quartile.

Prevalence of illness in preschoolers is also stratified by age (Table 30) and by nutritional status (Table 31). Illness tended to be most prevalent in the 7- to 24-month category and, to a lesser extent, the 25- to 36-month age group. The 7- to 24-month period corresponds with weaning for most children in the project area and is typically a time when morbidity escalates. Data in Table 30 suggest that as children get older and survive the weaning stage, overall morbidity tends to decrease.

Children classified as better nourished based on weight-for-age or weight-for-length were sick less frequently (Table 31), irrespective of the differences in income. The only indicator in which there was no difference between morbidity levels above and below the cutoff for adequate nutrition was stunting (Table 31). This reflects the fact that length-for-age, as a longer-term nutritional status indicator, is not a good discriminator for short-term illness.

Determinants of Morbidity for Preschoolers

The static comparisons presented in Tables 28 to 31 are supplemented by multivariate analyses of the determinants of illness for women and preschoolers, using the following functional form:

Morb_{ij} = f(Age, Sex, Household Size, Percent Children, Mother's Schooling, Father's Schooling, Income, Water Time, Latrine, Childcare, Health Expenditures, Age Solids, Percent Women, Mother's Height, Round 2, Round 3, Round 4, Agricultural Dummy, SugarArea),

Table 28—Percentage of time ill with any illness and with diarrhea, preschoolers and women, by activity group, 1984/85

Activity Group	Preschoolers Sample Size	Preschoolers Total Illness	Preschoolers Diarrhea	Women Sample Size	Women Total Illness	Women Diarrhea
		(percent)			(percent)	
Sugar farmers	425	27.4 (21.9)	4.9 (11.4)	245	27.3 (23.4)	1.5 (5.5)
Nonsugar farmers	646	27.3 (22.8)	6.1 (12.8)	367	28.2 (23.8)	2.9 (9.0)
New entrants	108	30.8 (21.6)	6.4 (12.0)	64	33.1 (22.9)	1.5 (6.7)
Landless	100	27.1 (18.9)	4.5 (9.2)	53	27.2 (17.6)	1.1 (5.2)
Wage earners	36	24.3 (14.7)	3.5 (7.7)	22	37.4 (26.5)	1.4 (5.3)
Merchants	72	24.4 (17.6)	5.4 (11.4)	37	23.8 (20.6)	0.7 (2.7)
All households	1,387	27.4 (21.8)	5.5 (11.9)	788	28.3 (23.2)	2.1 (7.4)

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.
Notes: No group was significant at the 0.05 level. Sample size (N) is the number of preschoolers or women in each activity group who had morbidity data reported for any round. The numbers in parentheses are standard deviations.

Table 29—Percentage of time ill with any illness and with diarrhea, preschoolers and women, by per capita income quartile, 1984/85

Illness	Income Quartile 1	Income Quartile 2	Income Quartile 3	Income Quartile 4
		(percent)		
Preschoolers				
Total illness[a]	27.5 (20.4)	26.0 (20.9)	29.5 (23.3)	26.5 (22.2)
Diarrhea[a]	4.9 (11.6)	6.4 (12.6)	6.2 (13.0)	4.6 (10.2)
Sample size	332	390	344	311
Women				
Total illness[a]	30.2 (21.6)	26.8 (22.9)	29.8 (25.2)	26.6 (22.6)
Diarrhea[b]	1.2 (4.9)	1.4 (5.3)	2.2 (6.7)	3.7 (11.0)
Sample size	177	212	206	189

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.
Notes: The quartiles are based on total household annual income per capita for the total sample, with 1 the lowest income group. The numbers in parentheses are standard deviations. Sample size (N) is the total number of children or women surveyed during the four rounds.

[a] There was no significant difference across income quartiles.

[b] Women in quartiles 1 and 2 reported significantly shorter duration of diarrhea at the 0.05 level than women in quartile 4.

Table 30—Percentage of preschoolers' time ill with any illness, by age of child and activity group, 1984/85

	Age in Months									
Activity Group	0-6 Months	Sample Size	7-24 Months	Sample Size	25-36 Months	Sample Size	37-48 Months	Sample Size	49-72 Months	Sample Size
	(percent)		(percent)		(percent)		(percent)		(percent)	
Sugar farmers	24.7 (27.6)	67	33.7 (21.1)	119	28.5 (21.4)	75	22.6 (17.6)	65	23.5 (20.1)	96
Nonsugar farmers	18.3 (21.0)	80	34.0 (22.9)	196	27.0 (20.2)	119	29.4 (23.5)	83	23.4 (22.7)	165
New entrants	28.8 (22.9)	15	36.1 (24.9)	36	32.8 (18.6)	20	29.8 (18.5)	14	22.7 (17.8)	23
Landless	21.8 (19.8)	20	29.8 (17.2)	28	30.8 (11.1)	18	37.7 (27.5)	12	19.6 (16.9)	22
Wage earners	22.6 (12.5)	4	30.1 (18.6)	16	16.4 (6.9)	5	21.6 (10.0)	3	19.4 (7.5)	8
Merchants	34.9 (21.9)	10	23.8 (15.7)	23	29.7 (17.5)	13	17.9 (16.4)	15	18.7 (15.2)	11
All households	22.6 (23.6)	196	33.1 (21.8)	418	28.1 (19.6)	250	26.6 (21.3)	192	22.9 (20.8)	325

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.
Notes: Time ill is determined by the duration of illness in the prior 14 days expressed as a percentage of total time. No group was significantly different at the 0.05 level. Sample size is the total number of children surveyed over a maximum of four rounds. The numbers in parentheses are standard deviations.

$Morb_{ij}$ = percentage of total time ill for child i in household j,
Age = age of the child in months,
Sex = zero-one dummy (1 if a male),
Household Size = number of people in households,
Percent Children = percentage of children in households,
Mother's Schooling = years of schooling of mother,
Father's Schooling = years of schooling of father,
Income = total annual income (KSh),
Water Time = time to get water (in hours),
Latrine = zero-one dummy (1 if a latrine is present),
Childcare = zero-one dummy (1 if the child is cared for by an adult while the mother is away),
Health Expenditures = percentage of total expenditures on health,
Age Solids = age (in months) of introduction to solid foods,
Percent Women = percentage of women in the household,
Mother's Height = height of the mother, in centimeters,
Round 2 = round dummy, 1 for round 2, 0 for other rounds,
Round 3 = round dummy, 1 for round 3, 0 for all other rounds,
Round 4 = round dummy, 1 for round 4, 0 for all other rounds,
Agricultural Dummy = zero-one dummy for type of household (1 if an agricultural household), and
SugarArea = total area of household land planted in sugar in hectares.

The same regression was specified, replacing the dependent variable "total time ill" with "percentage of total time ill with diarrhea."

The regression results for preschoolers in Table 32 show that there is a definite seasonal difference in the pattern of total illness for preschoolers. The total percentage of time ill decreases steadily from round 1 to round 4. The prevalence of illness is highest in the first round, which in this survey coincides with the lean preharvest season. However, this same pattern of sea-

Table 31—Percentage of time ill with any illness for preschoolers aged 6 to 72 months, by indicators of nutritional status and income quartile, 1984/85

	Weight-for Age				Weight-for-Length				Length-for-Age			
Income Quartile	Less Than 75 Percent	Sample Size	75 Percent or More	Sample Size	Less Than 90 Percent	Sample Size	90 Percent or More	Sample Size	Less Than 90 Percent	Sample Size	90 Percent or More	Sample Size
1	32.7 (24.3)	34	27.7 (19.6)	250	35.2[a] (22.6)	52	26.8[a] (19.4)	232	26.6 (20.4)	64	28.8 (20.2)	220
2	32.8[a] (20.3)	46	26.3[a] (20.9)	285	33.5[a] (20.8)	61	25.8[a] (20.7)	270	28.3 (18.9)	78	26.9 (21.5)	253
3	34.5 (21.8)	35	29.9 (23.0)	249	35.6[a] (23.6)	50	29.3[a] (22.6)	234	29.1 (22.2)	61	30.8 (23.0)	223
4	28.8 (27.7)	26	27.0 (20.6)	233	32.1 (26.9)	35	26.4 (20.4)	224	24.0 (22.4)	39	27.7 (21.1)	220

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Notes: Nutritional status indicators are a percentage of the U.S. National Center for Health Statistics' median standards. Inadequate nutrition is less than 75 percent of standard weight-for-age and less than 90 percent of standard weight-for-length and length-for-age.

[a] Duration of illness below the cutoff is significantly longer than that above the cutoff ($p<0.05$) within a quartile.

Table 32—Regression equations for total time ill and time ill with diarrhea for preschoolers

Independent Variable	Coefficient for Total Time Ill	Coefficient for Time Ill With Diarrhea
Income	−2.99 (−1.09)	4.22−06 (0.29)
Water time	−0.50 (−0.43)	−4.69−03 (−0.01)
Age for solids	−0.31 (−1.28)	−0.04 (−0.29)
Mother's height	−0.19 (−1.90)	−0.06 (−1.03)
Child care	0.99 (0.83)	−0.02 (−0.04)
Health expenditures	0.23[a] (2.30)	0.01 (0.22)
Latrine	−3.36[a] (−2.56)	−0.09 (−0.13)
Sex	−0.60 (−0.50)	−0.79 (−1.23)
Percent children	−0.06 (1.33)	0.01 (0.52)
HOH's schooling	−0.09 (−0.54)	−0.12 (−1.25)
Agricultural dummy	3.99 (1.95)[a]	2.50[a] (2.28)
Age	−0.18[a] (−5.29)	−0.17[a] (−9.22)
Sugar area	−0.03 (−0.92)	−0.04[a] (−2.62)
Household size	7.44−03 (0.06)	−0.04 (−0.63)
Percent women	−0.02 (−0.95)	−9.61−03 (−0.83)
Mother's schooling	0.11 (0.56)	−0.13 (−1.26)
Round 2 (dummy)	−5.80[a] (−3.50)	−0.64 (−0.73)
Round 3 (dummy)	−6.99[a] (−4.17)	−0.18 (−0.21)
Round 4 (dummy)	−7.63[a] (−4.50)	−0.67 (−0.74)
Constant	69.40 (4.26)	20.70 (2.36)
R^2	0.040	0.035
Degree of freedom	2,757	2,757
F	6.030	5.310

Note: The numbers in parentheses are t-values. HOH is head of household.

[a] This number is significant at the 0.05 level.

sonality is not present for diarrhea. Preschoolers are as likely to be sick with diarrhea in the postharvest as in the preharvest season, which reflects, in part, the generally poor sanitary conditions in the area throughout the year.

For children, age has a significant impact on both total illness and on prevalence of diarrhea (Table 32). Older children are less likely to be ill than their younger siblings. All else being equal, a four-year-old child will be sick 6 percent less than a one-year-old child. This corroborates the data presented in Table 30.

Not surprisingly, presence of a latrine in the household is associated with less total time ill. Preschoolers in a household with a latrine are sick 3 percent less than children from households without a latrine.

Health expenditures have a negative effect on total time ill because expenditures on health tend to be for therapeutic purposes. Households spend more on health care when children are sick.

Household income is not a significant determinant of total illness or diarrhea. Here again, this is consistent with the data in Tables 29 and 31. Area allocated to sugarcane production does, however, cause a significant decrease in the prevalence of diarrhea. One interpretation is that the expenditures associated with income from sugar result in health benefits to the child. It is quite plausible that expenditure on better housing from sugar income results in a home environment that leads to better health.

However, this modest benefit from sugar area is overwhelmed by the negative effect of the agricultural dummy on both total illness and diarrhea. All else being equal, children from agricultural households are, on average, ill for longer periods. Rural households are by definition farther from services, including health care. The agricultural dummy serves as a proxy for the general health and sanitation conditions within the community.

The model for preschooler health involves a complex interaction between household and child variables. The R^2 for both preschooler morbidity equations is low but typical of what is normally seen in multivariate analyses of this type.[23] No single variable in the model has a dramatic effect by itself. The results suggest that a number of factors, in combination, must be considered in order to have a substantial effect on child health.

Determinants of Morbidity for Women

The analysis of the determinants of morbidity in women follows a format similar to that for preschoolers. The following model was used:

$$\text{Wmorb}_{ij} = f(\text{Income, Water Time, Woman's Height, Health Expenditures, Percent Children, Husband's Schooling, Household Size, Percent Women, Latrine, Woman's Age, Agricultural Dummy, Woman's Schooling, SugarArea, Round 2, Round 3, Round 4}),$$

where

Woman's Height = actual height of the woman in centimeters,

Husband's Schooling = years of schooling of the husband,

Woman's Age = age of the woman in years, and

Woman's Schooling = years of schooling of the woman.

Table 33 shows a strong seasonal pattern of illness for women, similar to that for preschoolers. Morbidity is most prevalent in the preharvest season.

A higher household income has a small beneficial effect on the prevalence of diarrhea but no effect on total time ill for women. Women from agricultural households have a higher prevalence of diarrhea.

---

[23] For example, Levinson found an R^2 of 0.037 for the diarrhea equations for children using an ordinary least squares approach. See F. J. Levinson, *Morinda: An Economic Analysis of Malnutrition Among Young Children in Rural India,* Cornell/MIT International Policy Series (Ithaca, N.Y.: Cornell University Press, 1974).

Table 33—Regression equations for total time ill and time ill with diarrhea for women

Independent Variable	Coefficient for Total Time Ill	Coefficient for Time Ill With Diarrhea
Income	7.71–06 (0.25)	5.82[a]–05 (5.03)
Water time	0.89 (0.67)	0.65 (1.32)
Woman's height	−0.11 (−1.02)	−0.02 (−0.52)
Health expenditures	0.23 (1.79)	−0.04 (−0.79)
Percent children	8.07–03 (0.17)	−0.02 (−1.07)
Husband's schooling	−0.09 (−0.45)	−0.05 (−0.61)
Household size	−0.28[b] (−2.09)	−0.06 (−1.26)
Percent women	−0.02 (−0.87)	−2.45–03 (−0.28)
Latrine	−0.95 (−0.65)	−0.06 (−0.10)
Age	0.02[a] (3.13)	1.73–03 (0.58)
Agricultural dummy	2.87 (1.29)	1.83[b] (2.19)
Woman's schooling	−0.51[b] (−2.31)	−0.05 (−0.61)
Sugar area	−0.10[a] (−3.29)	−0.04[a] (−3.28)
Round 2 (dummy)	−6.65[a] (−3.56)	0.58 (0.83)
Round 3 (dummy)	−9.40[a] (−4.98)	−0.36 (−0.51)
Round 4 (dummy)	−10.58[a] (−5.66)	0.75 (0.69)
Constant	49.80 (2.79)	4.62 (0.69)
R^2	0.035	0.018
Degree of freedom	2,574	2,574
F	5.890	3.010

Source: International Food Policy Institute, "Survey 1984/85," South Nyanza, Kenya.
Note: The numbers in parentheses are t-values.
[a] This figure is significant at the 0.01 level.
[b] This figure is significant at the 0.05 level.

Women with more education and from larger households are less likely to be sick. This finding can be interpreted in two ways. The obvious explanation is that women with some education are better able to take advantage of information and services available within the community and thus to care for themselves. In addition, both of these factors presumably act as proxies for wealth. Older women are more likely to be sick than younger women. Finally, similar to what was seen for preschoolers, area of land allocated to sugarcane is associated with a decrease in the prevalence of diarrhea and in the total time ill for women.

There are some counterintuitive findings that emerge for both women and children. Total household annual income is not a significant determinant of total illness in either women or preschoolers. This is surprising given that conventional wisdom suggests that increases in a household's income will translate into improvements in the health and well-being of individuals within the household. Perhaps it is not simply absolute income but how the income is spent that has the major impact on health. This helps explain why a larger amount of farmland planted in sugar is associated with a significant decrease in the prevalence of diarrhea in women and preschoolers. Sugar area may be acting as a proxy for expenditure patterns, such as better housing and better sanitary conditions, that have a beneficial effect in alleviating diarrhea.

Whereas total illness for both women and children exhibits a seasonal pattern, diarrhea does not. This suggests that the poor health and sanitation conditions in the community are not cyclical, and thus conditions such as diarrhea are chronic and endemic to the area.

7

DETERMINANTS OF NUTRITIONAL STATUS OF WOMEN AND PRESCHOOLERS

The commercialization of semisubsistence agriculture is one type of income-generating strategy aimed at reaching the small-farm households in Kenya. The sugarcane outgrowers' program has many objectives, not least of which is the improvement in general health and well-being of the rural poor, including a reduction in preschooler malnutrition and a decrease in infant and child mortality. This chapter examines the effects on women and children of participation in the outgrowers' scheme.

Descriptive Analyses of Preschooler Growth

The Z-scores and percentage of standards for length-for-age, weight-for-age, and weight-for-length averaged for all four rounds are shown in Table 34.[24] There are no significant differences in any of the three indicators among the activity groups. This is a somewhat surprising finding given the differences in income across groups.

Most of the discussions thus far have assumed that the major effect of commercial agriculture on nutritional status is mediated through sugar production, hence the classification of farmers as either sugar or nonsugar farmers. However, other commercial crops are also produced in the area.

When agricultural households are reclassified into quartiles based on marketed agricultural income per capita, the average Z-scores and percentage of standards for each of the three anthropometric indicators in Table 35 are similar to those shown in Table 34. There are no significant differences in any of the indicators between high and low commercial agricultural groups. Commercial agricultural income per se does not have an effect on nutritional status.

Finally, the nutritional status indicators for children from the agricultural households are stratified by quartile of total income (Table 36). The data reflect the general conclusion that within most income quartiles, there are no differences in nutritional status indicators across groups. In the limited number of cases where significant differences occur (the second income quartile for weight-for-age and weight-for-length, for example), children of sugar households are better off than either nonsugar or new entrant groups.

There are no significant differences in the change in Z-scores between the first and last rounds in any of the groups.

Table 37 presents an analysis of the prevalence of wasting and stunting for all rounds combined. On average, 17.3 percent of the sample children are wasted (less than 90 percent of the standard weight-for-length) and 20.9 percent are stunted (less than 90 percent of the standard length-for-age); approximately one out of four children would be classified as moderately to severely malnourished based on weight-for-age. These data are consistent with national data from Kenya.[25]

---

[24] The U.S. National Center for Health Statistics Standards (NCHS) are used in calculating Z-scores and percentage of standards:

Z-Scores = (Actual Measurement − 50 Percentile Standard)/Standard Deviation of 50 Percentile Standard

NCHS standards are the basis for growth standards used by the World Health Organization and are considered appropriate as international standards.

[25] Republic of Kenya, *Situation Analysis of Children and Women in Kenya,* vols. 1-4 (Nairobi: Central Bureau of Statistics and Ministry of Finance and Planning, 1984).

Table 34—Mean values of key anthropometric indicators expressed as a percentage of NCHS reference median and Z-scores for children aged 6 to 72 months, by activity group

	Indicator of Nutritional Status					
	Length-for-Age		Weight-for-Age		Weight-for-Length	
Activity Group	Percent	Z-Score	Percent	Z-Score	Percent	Z-Score
Sugar farmers N = 356	94.8 (5.4)	−1.34 (1.37)	89.3 (11.6)	−1.03 (1.04)	98.5 (8.8)	−0.22 (0.91)
Nonsugar farmers N = 556	94.1 (5.6)	−1.50 (1.42)	87.6 (13.1)	−1.17 (1.19)	97.6 (8.8)	−0.31 (0.93)
New entrants N = 90	94.3 (6.3)	−1.46 (1.62)	88.1 (12.8)	−1.13 (1.18)	98.0 (8.7)	−0.27 (0.92)
Landless N = 77	94.2 (5.5)	−1.45 (1.40)	88.6 (13.3)	−1.06 (1.22)	98.9 (10.3)	−0.18 (1.10)
Wage earner N = 30	93.5 (4.9)	−1.65 (1.23)	83.8 (10.4)	−1.49 (0.96)	94.8 (8.1)	−0.59 (0.85)
Merchant N = 62	96.1 (5.4)	−0.99 (1.38)	91.2 (11.6)	−0.86 (1.08)	97.9 (8.5)	−0.27 (0.92)
Total sample mean N = 1,171	94.4 (5.6)	−1.42 (1.41)	88.3 (12.5)	−1.11 (1.14)	97.9 (8.9)	−0.28 (0.93)

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Notes: Standards of the U.S. National Center for Health Statistics are used as the reference median.

No group was significantly different. Sample size (N) is the number of children surveyed over a maximum of four rounds. The numbers in parentheses are standard deviations.

Determinants of Preschooler Nutritional Status

To identify the key determinants of preschooler growth, the following model was used for preschooler nutritional status:

NS_{ij} = f(Age, Sex, Household Size, Female Household Head, Farm Area, Diarrhea, Mother's Height, Child's Calories, Round 2, Round 3, Round 4),

where

NS_{ij} = nutritional status of each child i 6 to 72 months of age in household j, as measured by Z-scores, weight-for-age, length-for-age, or weight-for-length,

Age = age of a child in months,

Sex = zero-one dummy (1 if a male),

Household Size = total number of people in the household,

Female Household Head = zero-one dummy (1 if a household is headed by a female),

Farm Area = total landholdings in hectares,

Diarrhea = percentage of time ill with diarrhea in the last two weeks,

Mother's Height = height of the mother in centimeters,

Child's Calories = total energy intake of the child in kilocalories for the previous day,

Round 2 = round dummy, 1 for round 2, 0 for all other rounds,

Round 3 = round dummy, 1 for round 3, 0 for all other rounds, and

Round 4 = round dummy, 1 for round 4, 0 for all other rounds.

Table 38 presents the regressions for preschoolers' Z-scores. There are significant positive associations between preschoolers' caloric intake and Z-scores for length-for-age and weight-for-age and marginally significant associations for weight-for-length. However, the effect of diarrhea on weight-for-age and weight-for-length is much stronger than the child calorie variable.

Table 35—Average Z-scores and percentage of the standard length-for-age, weight-for-age, and weight-for-length for preschoolers, stratified by quartiles of annual marketed agricultural income

Quartiles of Marketed Agricultural Income	Length-for-Age			Weight-for-Age			Weight-for-Length		
	Z-Score	Sample Size	Percent of Standard	Z-Score	Sample Size	Percent of Standard	Z-Score	Sample Size	Percent of Standard
(KSh/capita)									
0.0-6.6	−1.27	281	95.0	−0.99	281	89.6	−0.26	280	98.2
6.7-21.8	−1.44	285	94.3	−1.03	286	89.2	−0.17	285	99.3
21.9-56.9	−1.29	299	94.9	−1.02	299	89.1	−0.27	299	97.9
57.0-293.4	−1.15	270	95.5	−1.08	270	91.1	−0.14	270	99.4
Total sample mean	−1.29	1,135	95.0	−0.97	1,136	89.7	−0.21	1,134	98.7

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Notes: Only agricultural households are included here. No two groups are significantly different at the 0.05 level. Standards of the U.S. National Center for Health Statistics are used as the reference median.

Unlike the total morbidity equations, seasonality has no consistent effect on Z-scores. Only the dummy for round 2 in the weight-for-length model is significant. This means that the level of wasting declined during the round following the lean period of round 1. Age significantly influences weight-for-age and weight-for-length Z-scores; older children are more likely to achieve growth closer to the standard.

Interestingly, male children do significantly worse than female preschoolers on all three measures of growth. This is contrary to what has been reported from some parts of Asia. The difference between the data from this study and the Asia data may be due to differences in child sex preference. Much of the literature from Asia suggests that boys are preferred over girls; female children are often disfavored in the allocation of food and health care.[26] In South Nyanza, there is no apparent preference for either boys or girls. When mothers were asked, "What do you want the sex of your next child to be?" the most common answer given (60.2 percent of the time) was "whatever God sends me."

Various explanations may account for the better nutritional status of female children. In Kenya, a bride price must be paid for female children upon marriage. Thus, the perceived economic value of female children may be greater in Africa than in Asia. Also, young girls, more than boys, may accompany their mother during the daily chores and may benefit from additional nurturing and feedings.

Children from female-headed households do significantly better on both of the longer-term measures of nutritional status (length-for-age and weight-for-age). This effect is mediated through something other than income because the income effect is reflected in morbidity and in child's calories, both of which are significant determinants of growth. One plausible explanation is that in female-headed households, women have more decisionmaking power, and this may result in more emphasis being put on nurturing activities that positively affect children. These findings on female-headed households are similar to those reported by Greer and Thorbecke for Kenya: the nutritional status of children from

---

[26] L. C. Chen; E. Huq; and S. d'Souza, "Sex Bias in the Family Allocation of Food and Health Care in Rural Bangladesh," *Population and Development Review* 7 (No. 1, 1981): 55.

Table 36—Indicators of nutritional status (expressed as Z-scores) for children aged 6 to 72 months for agricultural households, by income quartile

Measure/ Income Quartile	Sugar Farmers		Nonsugar Farmers		New Entrants	
	Mean Z-Score	Sample Size	Mean Z-Score	Sample Size	Mean Z-Score	Sample Size
Length-for-age						
1	−1.46 (1.48)	52	−1.55 (1.46)	171	−1.68 (1.38)	29
2	−1.14 (1.34)	70	−1.54 (1.40)	194	−1.24 (1.51)	27
3	−1.44 (1.39)	129	−1.50 (1.24)	90	−1.36 (2.09)	20
4	−1.30 (1.29)	107	−1.33 (1.53)	101	−1.58 (1.64)	14
Weight-for-age						
1	−1.06 (1.11)	52	−1.14 (1.25)	171	−1.28 (1.18)	29
2	$-0.91^{a,b}$ (0.99)	70	-1.22^{a} (1.20)	194	-1.31^{b} (0.99)	27
3	−1.08 (1.03)	129	−1.30 (1.11)	90	−0.76 (1.51)	20
4	−1.03 (1.08)	107	−1.02 (1.16)	101	−1.03 (0.96)	14
Weight-for-Length						
1	−0.18 (0.79)	52	−0.24 (0.96)	171	−0.28 (0.77)	29
2	-0.23^{b} (0.77)	70	−0.35 (0.96)	194	-0.67^{b} (0.68)	27
3	-0.20^{a} (1.03)	129	-0.45^{a} (0.90)	90	−0.13 (1.37)	20
4	−0.25 (0.91)	107	−0.24 (0.81)	101	−0.05 (0.49)	14

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Notes: Statistical t-tests are used to compare the means of the nutrition indicators within the quartile for sugar versus nonsugar farmers, sugar versus new entrant farmers, and nonsugar versus new entrants. Standards of the U.S. National Center for Health Statistics are used as the reference median.

Sample sizes are listed for the first indicator only and represent the total number of preschoolers within the quartile for the agricultural activity.

The numbers in parentheses are standard deviations.

[a] Sugar versus nonsugar farmers = $p < 0.05$.

[b] Sugar farmers versus new entrants = $p < 0.05$.

female-headed households was consistently better than children from other types of households.[27]

Household size and household landholdings are proxies for wealth. In the present models, neither of these variables have a significant impact on length-for-age, weight-for-age, or weight-for-length.

Tallness in the mother has a positive effect on a child's length-for-age, weight-for-age, and weight-for-length: this, in part, reflects the genetic endowment of the child

---

[27] Joel Greer and Erik Thorbecke, *Food, Poverty and Consumption Patterns in Kenya* (Geneva: International Labour Organisation, 1986).

Table 37—Percentage of children between the ages of 6 and 72 months below common cutoffs for nutritional status, by activity group, 1984/85

Activity Group	Sample Size	Length-for-Age	Weight-for-Age	Weight-for-Length
			(percent)	
Sugar farmers	356	17.7	20.8	12.9
Nonsugar farmers	556	23.0	29.3	19.6
New entrants	90	24.4	27.8	15.6
Landless	77	23.4	28.6	22.1
Wage earner	30	20.0	33.3	23.3
Merchant	62	12.9	17.7	16.1
Average or total	1,171	20.9	26.0	17.3

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Notes: Standards of the U.S. National Center for Health Statistics are used as the reference median for nutritional status indicators. Prevalence rates are less than 80 percent for weight-for-age and less than 90 percent for length-for-age and weight-for-length.

and partly indicates a wealth effect. Women from upper-income households tend to be taller.

Determinants of Women's Nutritional Status

Very few studies have attempted to assess the impact of agricultural policies on adult women. Typically, studies have concentrated on assessing women's nutritional status only to the extent that it might influence infant or child growth.

In this research, women's nutritional status is evaluated using height and weight. Table 39 shows the mean weight for women in each of the activity groups. Merchant women are significantly heavier than most groups. With the exception of women from merchant households, the average weight of women in each activity group is similar. For women in all groups, weight is lowest in round 1, immediately preceding the long-rains harvest. Merchant women are also significantly taller than women from the other activity groups, which may indicate that merchant women were nutritionally better off initially than other groups (Table 39).

The actual weight changes between rounds 1 and 4 are also shown in Table 39. There are no significant differences in the average weight change among women in any of the groups.

In order to identify the influence of key determinants on women's nutritional status, the following model was specified:

WNS_{ij} = f(Woman's Height, Female Household Head, Illness, Household Calories Predicted, Age, Farm Area, Household Size, Round 2, Round 3, Round 4),

where

WNS_{ij} = nutritional status of woman i in household j, as measured by weight in kilograms or weight-for-height squared,

Woman's Height = woman's height in centimeters,

Female Household Head = zero-one dummy (1 if household is headed by a female),

Illness = total percent of time ill in the past two weeks,

Household Calories Predicted = total household caloric intake for the full sample, predicted from the equation in Table 27,[28]

---

[28] Predicted household calories are used for each woman, including those with missing household consumption data.

Table 38—Z-score regressions for length-for-age, weight-for-age, and weight-for-length for preschoolers aged 6 to 72 months

	Z-Score		
Independent Variable	**Length-for-Age**	**Weight-for-Age**	**Weight-for-Length**
Diarrhea	−2.46−03 (−1.32)	−5.79−03 (−3.90)	−5.68−03 (−4.48)
Sex	−0.13 (−2.40)	−0.14 (−3.07)	−0.10 (−2.76)
Female household head	0.53 (3.03)	0.37 (2.70)	0.13 (1.10)
Mother's height	0.03 (5.90)	0.02 (5.50)	6.62−03 (2.10)
Child's calories	1.89−04 (3.43)	1.53−04 (3.49)	6.79−05 (1.82)
Household size	5.82−03 (1.06)	2.49 (0.57)	−3.99−04 (−0.11)
Age	−9.04−05 (−0.05)	2.62 (1.89)	3.29−03 (2.79)
Farm area	0.01 (1.57)	7.47−03 (1.40)	2.76−03 (0.61)
Round 2	0.03 (0.44)	0.09 (1.40)	0.11 (2.10)
Round 3	−0.05 (−0.69)	0.03 (0.51)	0.10 (1.80)
Round 4	0.07 (0.88)	0.06 (0.96)	0.04 (0.88)
Constant	−6.07 (−7.89)	−4.59 (−7.52)	−1.45 (−2.79)
R^2	0.026	0.031	0.020
Degree of freedom	2,781	2,781	2,781
F	6.64	8.17	5.13

Note: The numbers in parentheses are t-statistics.

Age = age of woman in years,
Farm Area = total landholdings in hectares,
Household Size = household size,
Round 2 = round dummy, 1 for round 2, 0 for all other rounds,
Round 3 = round dummy, 1 for round 3, 0 for all other rounds, and
Round 4 = round dummy, 1 for round 4, 0 for all other rounds.

In the regressions of woman's weight and weight-for-height squared[29] in Table 40, landholdings and household size have a positive significant association with both nutritional status indicators. Women from female-headed households are significantly heavier and have a greater body mass index. Household caloric intake has a significant effect in both models, but the size of this effect is small. The total time ill does not

---

[29] Weight-for-height squared is an index of body mass.

Table 39—Weight by rounds, and height for adult women in each activity group

Activity Group	Mean Weight				Absolute Change in Weight	Mean Height[d]
	Round 1[a]	Round 2[b]	Round 3[c]	Round 4[a]		
			(kilograms)			(centimeters)
New entrants	57.25	57.40	57.55	58.21	−1.23	160.24
Sample size	57	56	55	54	50	55
Sugar farmers	56.91	57.94	57.86	57.72	−0.20	161.75
Sample size	224	205	198	208	187	217
Nonsugar farmers	55.69	56.41	56.39	56.67	−0.95	161.03
Sample size	316	303	291	307	280	320
Merchants	61.47	61.63	63.31	63.30	−1.25	164.34
Sample size	47	43	39	37	33	42
Wage earners	54.26	55.27	53.78	54.40	−0.43	161.14
Sample size	22	17	19	19	18	21
Landless	55.56	57.60	57.59	56.95	−1.56	158.47
Sample size	51	47	46	50	45	51

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

[a] Merchant women are significantly heavier than all groups except new entrants at the 0.05 level.

[b] Merchant women are significantly heavier than women from nonsugar-growing households at the 0.05 level.

[c] Merchant women are significantly heavier than all groups except the landless at the 0.05 level.

[d] Women from sugar-growing and merchant households are significantly taller than women from other households at the 0.05 level.

exert a significant influence on either woman's weight or weight-for-height squared. The woman's height has a significant positive effect on weight. Similar to the nutritional status equations for children shown in Table 38, there is no apparent seasonal effect on either weight or weight-for-height squared.

Table 40—Regressions for women's weight and weight-for-height squared

Variable	Weight		Weight-for-Height Squared	
	β	t-Value	β	t-Value
	(kilograms)			
Mother's height	0.51	20.75[a]	−0.07	−7.79[a]
Female household head	4.64	5.64[a]	1.76	5.60[a]
Illness	−5.31E−03	−1.18	−2.32E−03	−1.36
Household calories predicted	1.69E−03	2.97[a]	6.44E−04	2.96[a]
Age	−2.35E−04	−0.14	1.13E−05	0.02[b]
Farm area	0.11	3.12[a]	0.04	3.19[a]
Household size	0.13	3.09	0.05	3.19[a]
Round 2	0.64	1.48	0.25	1.53
Round 3	0.64	1.48	0.25	1.49
Round 4	0.53	1.20	0.20	1.20
Constant	−32.23	−7.46	31.30	19.00
R^2		0.17		0.04
Regression		10		10
Residual		2,476		2,476
F		51.89		11.38

[a] This figure is significant at the 0.01 level.

[b] This figure is significant at the 0.05 level.

8

CONCLUSIONS

The commercialization of subsistence and semisubsistence agriculture is the cornerstone of economic development in many developing countries. Proponents of strategies advocating an emphasis on cash crops see this as a means of increasing the incomes of rural smallholders, providing employment for the landless, and stimulating growth linkages with other segments of the economy. An underlying assumption is that the economic gains will result in improvement in the welfare of the small farmers, including improvement in the health and well-being of household members.

Critics of commercialization argue that not only have the economic benefits not always materialized but in some cases the transition to commercial agriculture has had a negative influence on health and nutritional status.[30]

In Kenya, there has been some concern that in areas with increased cash cropping, particularly increased sugarcane production, deterioration of preschooler nutritional status has occurred. This study was initiated at the request of the government of Kenya and was conducted jointly with the National Council for Science and Technology and Kenyatta University.

Impact of Sugar Production on Agricultural Households

The results of this study suggest that commercial agriculture may have extremely positive effects on household income. The annual income of farmers in the sugarcane outgrowers' scheme is KSh 670 per capita higher than the income of nonsugar farmers in the same region. This is approximately 25 percent of income. Much of this income differential is due to agricultural sales—particularly of sugar: 73 percent of the difference in agricultural sales between sugar and nonsugar growers is attributed to sugar production.

Farmers are making a profit from sugar. The net returns to family labor for sugarcane are approximately three times higher than the daily agricultural wage rate.

Much of the sugar that is now grown in the project area is grown on plots of land that have historically been planted in maize; 95 percent of the land allocated to sugar was used for maize production.

Data from Table 4 show that the proportion of land under food crops—36 percent—is substantially less for sugar farmers than for nonsugar farmers (52.1 percent), but the decline in the percentage of land allocated to food crops by sugar farmers has not affected household food security. Food production has been maintained because of the larger amount of farmland held by sugar farmers, and quite possibly also because women control the basic staples.

In the drought year, 1984, the net returns to land were comparable for maize and sugar. In a nondrought year returns to land for maize should be superior to sugar. However, the amount of family labor devoted to sugar production is substantially less than that devoted to maize. Therefore, the net returns to family labor are superior for sugar.

The superior profitability of sugar compared to maize per day of household labor is due in large part to the pricing policy pursued by the Kenyan government. Since 1978, the producer price has increased both in real and nominal terms. If the government had used the world price of sugar, the situation would have been different. In three of the five years included in this study, average net income would have been negative if the outgrowers' cane price had been based on world sugar prices. The pricing policy for sugar in Kenya has worked to the advantage of the small producer.

---

[30] See von Braun and Kennedy, *Commercialization of Subsistence Agriculture*, for the pros and cons of these arguments.

The sugarcane outgrowers' program, as it is implemented in Kenya, significantly adds to household income, which in turn positively affects household calorie consumption. However, this benefit at the household level does not appear to influence the preschoolers' nutritional status. There is a growing awareness that factors at the family level may be poor predictors of a child's nutritional status.

In the present context morbidity patterns and sanitation variables have the most dramatic effects on growth of children. The health infrastructure must be taken into consideration when policymakers are trying to anticipate the effects of agricultural policies and programs. The data suggest that preventive, rather than curative, strategies may have more positive effects on child health. Low-cost, low-technology health innovations with a preventive focus can have a high payoff. In the sample, only 61 percent of all households had latrines, yet the presence of a latrine is one measure that clearly had a positive effect on children's health. More emphasis needs to be placed on the health implications of agricultural policies and projects with particular attention to ways to improve the health infrastructure in a given community.

The positive effect of the sugarcane scheme on income is apparent and should not be trivialized. However, it appears that the incremental income from sugarcane is being spent on categories such as housing and school fees, which, though beneficial in themselves, will not improve nutrition in the short run.

Residence in a female-headed household is another factor that has been shown to have a positive effect on nutritional status. There are several plausible explanations. First, there is a large body of literature indicating that when women control household income, they are more likely than men to spend incremental income on food.[31] This also appears to be true for this project. Table 41 indicates that women are more likely to be responsible for food expenditures than men, and, in general, they are more likely to spend on nurturing activities that have an observable nutritional benefit.

Second, sugar income is not perceived as household income but as "men's income" (Table 41). Because the expenditure responsibilities and concerns of men and women differ, it is not surprising that the money earned from sugar production is spent on items like housing and school fees—categories of nonfood expenditure that fall under the responsibility of men.

Part of the difference in expenditures by men and women may also relate to the periodicity of income. Women's income from food crops and trading activities comes in smaller, more regular amounts. This may influence how the money is spent. Men's income from sugar comes only every 18 to 24 months and is paid in one lump sum. Lumpy sources of income tend to be spent differently than small, regular sources of income.

However, overall food insecurity is not a major problem in the area. Availability of food in the project area does not seem to have been affected by shifting land from maize to sugarcane. Although the percentage of land allocated to maize and some other crops has decreased, the absolute area planted in food crops has not. This pattern of land allocation may change as smaller farms enter the sugar scheme.

If policymakers are interested in maximizing the effects on nutrition of increased income, several steps might be taken. First, if it is culturally appropriate, the contract for the cash crop—in this case, sugarcane—should include the wife's or wives' names as well as that of the head of the household. This would help foster the concept of household income rather than simply male income.

---

[31] Ibid.

Table 41—Decisionmaking on food expenditures and sugarcane income

Decisionmaker	Percentage of Households
Food expenditures	
Husband	15.5
Wife or wives	76.3
Joint decision	5.9
Other household members	2.3
Sugar income	
Husband	79.0
Wife or wives	5.5
Don't know	0.5
Joint decision	12.8
Other household members	2.3

Source: International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.

Second, payments for the sugar crop could be broken down into smaller, more frequent increments. Periodic payments—advances against anticipated production—might ensure that the marginal propensity to spend on food would be higher than it is with lumpy income.

Finally, there is an issue that has not been touched on directly in the study but warrants discussion. The community in which the outgrowers' scheme has been implemented is one where malnutrition is endemic. There may not be an awareness on the part of households that malnutrition is in fact a problem because their children look like all other children in the community. The outgrowers' program, which involves approximately 30 percent of the households in the community, would be an excellent and visible way to reach a significant portion of the community regarding the nutritional needs of the maternal and child population. Nutrition education integrated into a primary health care delivery system could have a significant effect on the health and sanitary environment of the child.

To date, most of the farmers who have joined the outgrowers scheme have remained. Given the way the program now operates, it is unlikely that there will be a mass exodus back to food crop production. As long as farmers are making a profit, they will probably stay in the scheme.

Cash cropping is a reality in developing countries and a definite part of most agricultural development strategies. Some fine tuning of the program, however, would help maximize the potential impact of the increased income on the nutritional status of households and preschoolers.

BIBLIOGRAPHY

Braun, Joachim von, and Kennedy, Eileen. *Commercialization of Subsistence Agriculture: Income and Nutritional Effects in Developing Countries.* Working Paper on Commercialization of Agriculture and Nutrition No. 1. Washington, D.C.: International Food Policy Research Institute, 1986.

Chen, L. C.; Huq, E.; and d'Souza, S. "Sex Bias in the Family Allocation of Food and Health Care in Rural Bangladesh." *Population and Development Review* 7 (No.1, 1981): 55.

Cogill, Bruce. "The Effects on Income, Health, and Nutritional Status of Increasing Agricultural Commercialization in South-Western Kenya." Ph.D. thesis, Cornell University, 1987.

Food and Agriculture Organization of the United Nations. *Food Composition Table for Use in Africa.* Rome: FAO, 1968.

Greer, Joel, and Thorbecke, Erik. *Food, Poverty and Consumption Patterns in Kenya.* Geneva: International Labour Organisation, 1986.

International Food Policy Research Institute. "Survey 1984/85." South Nyanza, Kenya.

Kennedy, Eileen, and Cogill, Bruce. "A Sugarcane Outgrowers' Scheme in Kenya: The Case of SONY." International Food Policy Research Institute, Washington, D.C., February 1987 (mimeographed).

Kenya, Republic of. *Economic Survey—1982.* Nairobi: Central Bureau of Statistics, 1982.

______. *National Food Policy Paper.* Sessional Paper 4. Nairobi: Government Printer, 1981.

______. *Situation Analysis of Children and Women in Kenya,* Vols. 1-4. Nairobi: Central Bureau of Statistics and Ministry of Finance and Planning, 1984.

______. *Soils of Kisii.* Nairobi: Government Printer, 1982.

Levinson, F. J. *Morinda: An Economic Analysis of Malnutrition Among Young Children in Rural India.* Cornell/MIT International Policy Series, 1974.

National Center for Health Statistics of the United States. *NCHS Growth Curves for Children Birth to Eighteen Years—United States.* Washington, D.C.: U.S. Department of Health, Education, and Welfare, 1977.

Pinckney, Coty, and Muthaka, J. K. "A Summary Report on the Food Situation in Kenya." Ministry of Agriculture, Kenya, July 1984 (mimeographed).

South Nyanza Sugar Company. "Agronomy Report, 1984." South Nyanza, Kenya, 1984 (mimeographed).

______. Records provided by the company.

U.S. Department of Agriculture. *Composition of Foods.* Agriculture Handbook No. 8. Washington, D.C.: U.S. Department of Agriculture, 1975.

RECENT IFPRI RESEARCH REPORTS (continued)

43 *CLOSING THE CEREALS GAP WITH TRADE AND FOOD AID,* January 1984, by Barbara Huddleston

42 *THE EFFECTS OF FOOD PRICE AND SUBSIDY POLICIES ON EGYPTIAN AGRICULTURE,* November 1983, by Joachim von Braun and Hartwig de Haen

41 *RURAL GROWTH LINKAGES: HOUSEHOLD EXPENDITURE PATTERNS IN MALAYSIA AND NIGERIA,* September 1983, by Peter B. R. Hazell and Ailsa Röell

40 *FOOD SUBSIDIES IN EGYPT: THEIR IMPACT ON FOREIGN EXCHANGE AND TRADE,* August 1983, by Grant M. Scobie

39 *THE WORLD RICE MARKET: STRUCTURE, CONDUCT, AND PERFORMANCE,* June 1983, by Ammar Siamwalla and Stephen Haykin

38 *POLICY MODELING OF A DUAL GRAIN MARKET: THE CASE OF WHEAT IN INDIA,* May 1983, by Raj Krishna and Ajay Chhibber

37 *SERVICE PROVISION AND RURAL DEVELOPMENT IN INDIA: A STUDY OF MIRYALGUDA TALUKA,* February 1983, by Sudhir Wanmali

36 *AGRICULTURE AND ECONOMIC GROWTH IN AN OPEN ECONOMY: THE CASE OF ARGENTINA,* December 1982, by Domingo Cavallo and Yair Mundlak

35 *POLICY OPTIONS FOR THE GRAIN ECONOMY OF THE EUROPEAN COMMUNITY: IMPLICATIONS FOR DEVELOPING COUNTRIES,* November 1982, by Ulrich Koester

34 *EGYPT'S FOOD SU[illegible]DY AND RATIONING SYSTEM: A DESCRIPTION,* October 1982, by Harold Alderman, [illegible]im von Braun, and Sakr Ahmed Sakr

33 *AGRICULTURAL [illegible]OWTH AND INDUSTRIAL PERFORMANCE IN INDIA,* October 1982, by C. Rangarajan

32 *FOOD CONSUMPTION PARAMETERS FOR BRAZIL AND THEIR APPLICATION TO FOOD POLICY,* September 1982, by Cheryl Williamson Gray

31 *SUSTAINING RAPID GROWTH IN INDIA'S FERTILIZER CONSUMPTION: A PERSPECTIVE BASED ON COMPOSITION OF USE,* August 1982, by Gunvant M. Desai

30 *INSTABILITY IN INDIAN FOODGRAIN PRODUCTION,* May 1982, by Peter B. R. Hazell

29 *GOVERNMENT POLICY AND FOOD IMPORTS: THE CASE OF WHEAT IN EGYPT,* December 1981, by Grant M. Scobie

28 *GROWTH AND EQUITY: POLICIES AND IMPLEMENTATION IN INDIAN AGRICULTURE,* November 1981, by J. S. Sarma

27 *AGRICULTURAL PRICE POLICIES UNDER COMPLEX SOCIOECONOMIC AND NATURAL CONSTRAINTS: THE CASE OF BANGLADESH,* October 1981, by Raisuddin Ahmed

26 *FOOD SECURITY IN THE SAHEL: VARIABLE IMPORT LEVY, GRAIN RESERVES, AND FOREIGN EXCHANGE ASSISTANCE,* September 1981, by John McIntire

25 *INSTABILITY IN INDIAN AGRICULTURE IN THE CONTEXT OF THE NEW TECHNOLOGY,* July 1981, by Shakuntla Mehra

24 *THE EFFECTS OF EXCHANGE RATES AND COMMERCIAL POLICY ON AGRICULTURAL INCENTIVES IN COLOMBIA: 1953-1978,* June 1981, by Jorge García García

Eileen T. Kennedy has been a research fellow at the International Food Policy Research Institute since January 1984. Bruce Cogill, formerly a research analyst, currently serves as a consultant to the Institute.

RECENT IFPRI RESEARCH REPORTS

62 *AGRICULTURAL RESEARCH IN NEPAL: RESOURCE ALLOCATION, STRUCTURE, AND INCENTIVES,* September 1987, by Ram P. Yadav

61 *THE PILOT FOOD PRICE SUBSIDY SCHEME IN THE PHILIPPINES: ITS IMPACT ON INCOME, FOOD CONSUMPTION, AND NUTRITIONAL STATUS,* August 1987, by Marito Garcia and Per Pinstrup-Andersen

60 *POPULATION POLICY AND INDIVIDUAL CHOICE: A THEORETICAL INVESTIGATION,* June 1987, by Marc Nerlove, Assaf Razin, and Efraim Sadka

59 *PRODUCTION INCENTIVES IN PHILIPPINE AGRICULTURE: EFFECTS OF TRADE AND EXCHANGE RATE POLICIES,* May 1987, by Romeo M. Bautista

58 *THE FOOD STAMP SCHEME IN SRI LANKA: COSTS, BENEFITS, AND OPTIONS FOR MODIFICATION,* March 1987, by Neville Edirisinghe

57 *CEREAL FEED USE IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 2000,* December 1986, by J. S. Sarma

56 *THE EFFECTS OF TRADE AND EXCHANGE RATE POLICIES ON AGRICULTURE IN ZAIRE,* November 1986, by Tshikala B. Tshibaka

55 *THE EFFECTS OF TRADE AND EXCHANGE RATE POLICIES ON AGRICULTURE IN NIGERIA,* October 1986, by T. Ademola Oyejide

54 *WEATHER AND GRAIN YIELDS IN THE SOVIET UNION,* September 1986, by Padma Desai

53 *REGIONAL COOPERATION TO IMPROVE FOOD SECURITY IN SOUTHERN AND EASTERN AFRICAN COUNTRIES,* July 1986, by Ulrich Koester

52 *FOOD IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 2000,* June 1986, by Leonardo A. Paulino

51 *DETERMINANTS OF AGRICULTURAL POLICIES IN THE UNITED STATES AND THE EUROPEAN COMMUNITY,* November 1985, by Michel Petit

50 *GOVERNMENT EXPENDITURES ON AGRICULTURE AND AGRICULTURAL GROWTH IN LATIN AMERICA,* October 1985, by Victor J. Elías

49 *LIVESTOCK PRODUCTS IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 1990 AND 2000,* April 1985, by J. S. Sarma and Patrick Yeung

48 *RURAL HOUSEHOLD USE OF SERVICES: A STUDY OF MIRYALGUDA TALUKA, INDIA,* March 1985, by Sudhir Wanmali

47 *EVOLVING FOOD GAPS IN THE MIDDLE EAST/NORTH AFRICA: PROSPECTS AND POLICY IMPLICATIONS,* December 1984, by Nabil Khaldi

46 *THE EFFECTS ON INCOME DISTRIBUTION AND NUTRITION OF ALTERNATIVE RICE PRICE POLICIES IN THAILAND,* November 1984, by Prasarn Trairatvorakul

45 *THE EFFECTS OF THE EGYPTIAN FOOD RATION AND SUBSIDY SYSTEM ON INCOME DISTRIBUTION AND CONSUMPTION,* July 1984, by Harold Alderman and Joachim von Braun

44 *CONSTRAINTS ON KENYA'S FOOD AND BEVERAGE EXPORTS,* April 1984, by Michael Schluter

(continued on inside back cover)

International Food Policy Research Institute
1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 USA

R5620-1.9F (A)
5/88

RESEARCH REPORT 64

COOPERATIVE DAIRY DEVELOPMENT IN KARNATAKA, INDIA: AN ASSESSMENT

Harold Alderman

December 1987

INTERNATIONAL
FOOD
POLICY
RESEARCH
INSTITUTE

The **International Food Policy Research Institute** was established in 1975 to identify and analyze alternative national and international strategies and policies for meeting food needs in the world, with particular emphasis on low-income countries and on the poorer groups in those countries. While the research effort is geared to the precise objective of contributing to the reduction of hunger and malnutrition, the factors involved are many and wide-ranging, requiring analysis of underlying processes and extending beyond a narrowly defined food sector. The Institute's research program reflects worldwide interaction with policymakers, administrators, and others concerned with increasing food production and with improving the equity of its distribution. Research results are published and distributed to officials and others concerned with national and international food and agricultural policy.

The Institute receives support as a constituent of the Consultative Group on International Agricultural Research from a number of donors including the United States, the World Bank, Japan, Canada, the United Kingdom, the Netherlands, Australia, the Ford Foundation, Italy, Norway, the Federal Republic of Germany, India, the Philippines, Switzerland, Belgium, and the People's Republic of China. In addition, a number of other governments and institutions contribute funding to special research projects.

Board of Trustees

Dick de Zeeuw
Chairman, Netherlands

Ralph Kirby Davidson
Vice Chairman, U.S.A.

Eliseu Roberto de Andrade Alves
Brazil

Yahia Bakour
Syria

Ivan L. Head
Canada

Dharma Kumar
India

Anne de Lattre
France

James R. McWilliam
Australia

Philip Ndegwa
Kenya

Saburo Okita
Japan

Sukadji Ranuwihardjo
Indonesia

Theodore W. Schultz
U.S.A.

Leopoldo Solís
Mexico

M. Syeduzzaman
Bangladesh

Charles Valy Tuho
Côte d'Ivoire

John W. Mellor, Director
Ex Officio, U.S.A.

COOPERATIVE DAIRY DEVELOPMENT IN KARNATAKA, INDIA: AN ASSESSMENT

Harold Alderman

Research Report 64
International Food Policy Research Institute
December 1987

Copyright 1987 International Food Policy
Research Institute.

All rights reserved. Sections of this report may be reproduced without the express permission of but with acknowledgment to the International Food Policy Research Institute.

Library of Congress Cataloging
in Publication Data

Alderman, Harold, 1948-
Cooperative dairy development in Karnataka, India.

(Research report / International Food Policy Research Institute ; 64)
"December 1987."
Bibliography: p. 57.
1. Dairying, Cooperative—India—Karnataka. I. Title. II. Series: Research report (International Food Policy Research Institute) ; 64.

SF245.I42K373 1987 334'.68362142'095487
87-36666 ISBN 0-89629-066-2

CONTENTS

Foreword

1. Summary 7

2. Introduction 9

3. The Context of the Study 10

4. Conceptual Framework 15

5. Milk Production 17

6. Milk Marketing 29

7. Direct Measurement of the Effect on Consumption 33

8. Changes in Expenditure and Income Distribution 48

9. Conclusions 51

10. Policy Implications 54

Bibliography 57

TABLES

1. Daily household milk production, January 1983-April 1984 17

2. Milk yields per lactating animal and daily milk production, by animal type, January 1983-April 1984 17

3. Milk production by landholding category, January 1983-April 1984 18

4. Tobit regressions explaining the number of animals stocked, January 1983-April 1984 21

5. Probit results for probability of lactation, January 1983-April 1984 22

6. Coefficients of production functions, January 1983-April 1984 24

7. Daily feed inputs per animal, January 1983-April 1984 25

8. Coefficients from the feed demand equations, January 1983-April 1984 26

9. Results of regressions explaining milk prices, January 1983-April 1984 30

10. Use of milk production, January 1983-April 1984 31

11. Budget shares allocated to food groups, January 1983-April 1984 34

12. Calorie and protein consumption, January 1983-April 1984 34

13. Per capita daily energy consumption by quartiles of land cultivated per capita, January 1983-April 1984 35

14. Retail prices, by round, January 1983-April 1984 36

15. Coefficients of demand equations, January 1983-April 1984 38

16. Income and price elasticities estimated from combined cross-sectional data, January 1983-April 1984 39

17. Variations of basic milk demand equations, January 1983-April 1984 41

18. Income and price elasticities estimated from panel estimates, January 1983-April 1984 47

19. Ratio of the value of milk production to total expenditures, by landholding class, January 1983-April 1984 49

20. Changes in milk, calorie, and protein consumption attributed to dairy cooperatives in Karnataka, January 1983-April 1984 53

FOREWORD

Commercialization of agriculture has great potential for increasing gains from trade in rural regions and for utilizing interregional and interhousehold differences in resources more fully. In recent years, many countries have attempted to expand the range of their agricultural exports into high-value products, such as meat, poultry, horticultural, and dairy products. Moreover, as incomes in developing countries rise, domestic markets for these products also expand.

Increased commercialization of semisubsistence agriculture is not, however, without its pitfalls. It exposes farmers to new risks as well as new opportunities—opportunities that may not be equally available to all sectors, with a consequent potential for worsening patterns of income distribution. Finally, increasing trade in agricultural commodities may lead to changes in rural price environments.

IFPRI has undertaken extensive research to examine these issues. Results published so far include *Income and Nutritional Effects of the Commercialization of Agriculture in Southwestern Kenya,* Research Report 63, and two working papers in a cash cropping series: *Commercialization of Subsistence Agriculture: Income and Nutritional Effects in Developing Countries,* Working Paper 1, and *Cooperatives and the Commercialization of Milk Production in India: A Literature Review,* Working Paper 2.

This study uses household level data to assess cooperative dairy promotion in Karnataka, India. The scale of India's programs to increase milk production and to market more milk in its cities is large and so is the controversy generated by it. By focusing on one region in India, the study provides a perspective that complements other studies on dairy development in particular and the research on commercialization of semisubsistence agriculture in general.

John W. Mellor

Washington, D.C.
December 1987

ACKNOWLEDGMENTS

The author owes debts of gratitude to Joachim von Braun, Angus Deaton, Richard Just, Per Pinstrup-Andersen, and Roger Slade for advice on improving earlier drafts. Discussions with George Mergos were also helpful. Devi Katikineni provided excellent support as a research assistant. This research was funded by the World Bank and the Danish International Development Agency (DANIDA).

1

SUMMARY

The Karnataka Dairy Development Project was inaugurated in 1974 with the assistance of the World Bank. It is an example of an approach to agricultural development that emphasizes integrating rural households into a market economy by increasing the use of purchased inputs and increasing the marketed surplus. Such approaches have been controversial because it is alleged that the commercialization of agriculture that is a part of the approach worsens the distribution of income and the nutrition of the local population. The evidence available about such approaches is scant, even though the Karnataka project is modeled closely on the larger Operation Flood dairy development project, which has been at the center of these debates.

The study uses multivariate regression techniques to analyze data from five rounds of household surveys collected in two of the three ecological zones of Karnataka covered by the Karnataka Dairy Development Project. The households surveyed in each zone came from 21 villages with cooperatives and 10 villages without. The latter acted as a control group.

The data on milk production showed that the villages with cooperatives produced about twice as much milk as the villages in the control group. This difference can be attributed mostly to the larger number of crossbred cows and buffalo in the cooperative villages. But the presence of a cooperative seemed not to affect the yield of an animal (controlling for breed) per amount of feed or the probability that it would be lactating, both of which reflect management practices. And the differences in feeding rates were slight. It has often been assumed that the amount of labor used per animal increases if a cooperative is established, but no differences between the two sets of communities were found. Labor use, in fact, changed only with the size of the herd and its composition. But because those effects were offset by reductions in the use of labor per animal as herd size increased, the net differences in labor use were small.

Dairying seemed to have no influence on cropping patterns: in the entire sample, less than 4 hectares were used to produce fodder in any one round. Nor did the cooperatives seem to influence nondairy farm profits: they had no observable effect on input prices and increased the amount of household labor employed directly in food production only slightly.

The intent of the dairy development project was to raise producer prices without raising consumer prices. Producers in the villages with cooperatives did receive higher prices than producers in the control villages; the price of buffalo milk was 3 percent higher. This is a statistically significant difference. The price of cow milk was also higher, though by a less significant margin.

Tests designed to show the net effects of the commercialization of dairy production on food consumption showed that increases in the prices of rice and ragi reduced consumption of kilocalories and protein significantly. Whereas consumption of dairy products changed significantly with changes in milk prices, there was little impact on nutrient consumption due to substitution between calories. There appears to be less need for concern about the effects of local milk prices on nutrition than about the effects of local cereal prices on nutrient intake.

The presence of a cooperative tended to reduce the milk consumption of households (with differences in prices and income controlled for), whether they were members of a cooperative or not. But the nutrient consumption of nonproducers fell, while the nutrient consumption of producers increased because their income increased.

Cooperatives did appear to increase the incomes of the households in the cooperative villages. The incomes of larger landholders increased more than the incomes of smaller landholders, but relative, as opposed to absolute, income differences did not increase. No group lost absolutely. There was no net negative effect on the income distribution, though the positive relationship between dairy earnings and the size of landholding makes this conclusion worthy of further study.

Taken as a whole, the study shows that cooperatives are slowly transforming dairy production by replacing local breeds of cows with crossbred cows and buffalo. And farmers seem to prefer the latter. But cooperatives are not increasing the amount of inputs per animal type, nor are they changing fodder production. Consequently, the full potential of the crossbred cows, which require larger amounts of feed but produce more milk than local cows, is not being fulfilled. Both the changes in breeds and the lack of change in inputs show differences between the preferences of planners and farmers that should be taken under advisement in developing policy.

2

INTRODUCTION

Most approaches to agricultural development promote the integration of rural households with a market economy by increasing the use of purchased inputs and by increasing the marketed surplus. Such strategies frequently focus on high-value noncereal crops to earn or save foreign exchange or to meet rapidly growing demand for meat and produce in urban areas. While such cash-cropping strategies may create linkages between sectors of the economy,[1] they often have pitfalls that differ from problems associated with developing semisubsistence agriculture. They expose rural economies to the vagaries of interregional or international trade and the hazards of reliance on poorly developed internal transportation networks. In addition, an emphasis on commercialization of agriculture is alleged to have regressive effects on local income distribution and to worsen the nutrition of the local population. Available evidence on these problems is scant, however, even though crops are produced primarily for sale in many regions.[2]

An example of an agricultural development program that has promoted increased links between hitherto isolated producers of high-value agricultural commodities and an urban marketing grid is the Indian dairy development project known as Operation Flood. The scheme, begun in 1970, was intended to integrate 10 million milk producers into a network of small cooperatives, processors, and marketing unions by 1986. The program is presented as a model use of foreign aid and as an example of smallholder-oriented rural development by its supporters and as a public relations hoax by its more extreme critics.[3]

At times the debate on the merits of Operation Flood has been contentious, reflecting, at least in part, the amount of the resources involved. The first phase of Operation Flood required an investment of Rs 1,300 million.[4] The second phase is projected to cost nearly Rs 4,800 million. Much of the debate centers on which of Operation Flood's goals are worthwhile rather than on whether the goals have been met. But the debate has also focused on specific, measurable, microlevel questions. These include: Has dairy development led to increased production or only changed marketing patterns? Have there been any benefits and have they been equitably distributed? Has the promotion of milk as a cash crop contributed to a decline in rural nutrition? This study is intended to contribute to the quantitative evaluation of this cash-cropping approach in terms of its effects on the production and consumption of food in general and milk in particular, using the Karnataka Dairy Development Project for the study, which, although not formally under Operation Flood, is structured in the same way. In addition to being a case study, it is intended to contribute to the general question of the evaluation of the nutritional effects of commercialization on semisubsistence agriculture.

---

[1] John W. Mellor, *The New Economics of Growth: A Strategy for India and the Developing World* (Ithaca, N.Y.: Cornell University Press, 1976).

[2] Joachim von Braun and Eileen Kennedy, *Commercialization of Subsistence Agriculture: Income and Nutritional Effects in Developing Countries,* Working Papers on Commercialization of Agriculture and Nutrition 1 (Washington, D.C.: International Food Policy Research Institute, 1986).

[3] A review of much of the literature on Operation Flood is presented in Harold Alderman, George Mergos, and Roger Slade, *Cooperative Dairy Development in India: Evolution, Debate, and Evidence,* Working Papers on Commercialization of Agriculture and Nutrition 2 (Washington, D.C.: International Food Policy Research Institute, 1987). See also Michael Lipton, "Indian Agricultural Development and African Food Strategies: A Role for the EEC," in *India and the European Community,* ed. W. Callewaert (Brussels: Center for European Policy Studies, 1985).

[4] A dollar was worth between Rs 7.3 and Rs 8.9 in the period 1970-79. It rose to Rs 12.45 by 1984.

3

THE CONTEXT OF THE STUDY

While the responsibility for agricultural development programs in India is shared by the states and the central government, the main program for dairy development in India is the federally sponsored project, Operation Flood. The project, initiated in 1970, has its antecedents in a private cooperative scheme first organized in Anand, in the Kaira district of Gujarat in 1946.[5] An essential feature of this approach is the establishment of thousands of producer cooperatives that regularly collect milk in the villages, ensure its quality, provide prompt payment to producers, encourage improved management techniques, and facilitate access to veterinary services and marketed inputs. These cooperatives are linked through unions in order to use chilling plants and factories that process fluid milk into storage products more effectively and, in so doing, to use flush season production more efficiently.

Operation Flood

Operation Flood has attracted international attention, in part because it is a major recipient of food aid.[6] Most of this aid comes as milk powder and butter oil, which are used in processing centers during slack seasons of domestic milk production. The reconstituted milk is then sold through the market grid, allowing the program to generate funds and maintain marketing channels. The amount of this aid raises the usual controversial questions of dependency and disincentives to domestic producers. However, this aid is also presented as an example of how to use commodity aid creatively to promote agricultural development.

The marketing goals of the program can be evaluated readily by monitoring the amount of milk delivered to the urban grid. This, however, may merely show a shift of marketing channels and not an increase in production.[7] Flood, however, does include a strategy for increasing dairy production. Given perceived grazing constraints and shortages of concentrates as well as the low productivity of indigenous breeds, it was not thought feasible either to increase the herd size or to increase the amount of inputs given to local animals.[8] While some attention has been given to increasing productivity through better husbandry, a major pillar of Operation Flood is the strategy of upgrading the quality of the national herd. This is to be achieved by increasing the number of crossbred cows while holding the size of the total national herd constant, or even reducing it.[9] While some studies have evaluated the production and consumption effects of the program on the household, they have generally been designed as quasiexperiments that match cooperative villages with similar nonprogram villages.[10] Such an approach, which often compares mean values between villages, is highly sensitive to the choice of villages and their comparability. This study, like a companion study in Madhya Pradesh,[11] attempts to improve on previous empirical household studies by employing multivariate regression techniques rather than by comparing village means.

---

[5] Operation Flood is reviewed in Alderman, Mergos, and Slade, *Cooperative Dairy Development in India.* The history of the Anand scheme is presented by S. P. Singh and P. Kelley, *AMUL: An Experiment in Rural Economic Development* (New Delhi: Macmillan, 1981).

[6] Lipton, in "Indian Agricultural Development," records that between 1970 and 1981, Rs 1.5 billion in aid was provided for the program, 80 percent of which came through commodity aid from the World Food Programme and the European Economic Community.

[7] Piet Terhal and Martin Doornbos, "Operation Flood: Development and Commercialization," *Food Policy* 8 (August 1983): 235-239.

[8] National Dairy Development Board, *Breeding and Feeding for Milk Production in Operation Flood II* (Anand: NDDB, 1980).

[9] Ibid. This strategy is also discussed in Surendar Singh, "Operation Flood II: Some Constraints and Implications," *Economic and Political Weekly* (October 1979): 1765-1774; and K. Nair and M. Jackson, "Alternatives to Operation Flood II Strategy," *Economic and Political Weekly* (December 1981): 2129-2132.

Neither the Karnataka or Madhya Pradesh projects were administered under Operation Flood. This, however, is a distinction largely based on sources of funding; both states modeled their projects on the Anand scheme and included advisors from the National Dairy Development Board, which oversees Operation Flood.

The Setting in Karnataka

The Karnataka Dairy Development Project was inaugurated in 1974.[12] The project is based on a three-tier organization with the Karnataka Dairy Development Corporation (KDDC) at the apex and the village cooperative network being the base.[13] Four regional milk producer unions link the two. The KDDC was formed with a total capitalization of Rs 465 million, 247 million of which came from the World Bank and the remainder from the central and state governments.[14]

By September 1984 there were 1,875 functioning cooperatives, with a total membership of 313,000. Official figures indicate that 6.0 percent of these members came from families with landless laborers and 21.5 percent came from marginal farming families (less than 1 hectare holdings).[15]

These cooperatives serve as a catchment for the southern and hilly regions of the state—that is, three of the state's six ecological zones. The districts of Bangalore, Mysore, and Hassan, among others, are included in the catchment. Processing plant capacity reached 500,000 liters daily in 1981 and 650,000 by 1985.

The project proposed to increase production by improving animal nutrition and by crossbreeding. The former would be achieved by promoting cultivation of fodder and by supplying concentrates manufactured at local mills with a total capacity of 500 tons per day. This was revised downward to 200 tons per day. The breeding program would use frozen semen from Jersey and Friesian bulls and would be augmented by expanding veterinary and vaccination services through the cooperative societies.

Karnataka as a whole has had moderate rates of increase in agricultural production. Although less rapid and sustained than those in northern India, these rates have still been above the Indian average.[16] Milk production in the state increased 8.1 percent in the two-year period from 1977/78 to 1979/80, compared to 6.5 percent for India as a whole.

Detailed studies of dairy production are scarce. While the National Sample Survey provides some detailed information, the results for 1975/76 were not published until 1984.[17] That report indicates that the average daily production of milk in Karnataka was 0.83 a day from cows and 1.3 liters a day from buffalo. These were 79 and 59 percent of national averages for that year.

---

[10] See Alderman, Mergos, and Slade, *Cooperative Dairy Development.*

[11] George Mergos and Roger Slade, *Dairy Development and Milk Cooperation: The Effects of a Dairy Project in India,* World Bank Discussion Paper 15 (Washington, D.C.: World Bank, July 1987).

[12] This section draws on the notes of Professor T. K. Lakshman, former director of research of the Centre for Rural Development Studies, University of Bangalore, who was a principal collaborator in this study. Lakshman was participating in this research at the time of his death.

[13] The KDDC is now the Karnataka Cooperative Milk Producer's Federation.

[14] Katar Singh, R. Srinivasan, and K. V. Raju, *Project Completion Report: Karnataka Dairy Development Project.* (Anand: Institute of Rural Management, 1985).

[15] Ibid.

[16] S. Sawart, "Investigation of the Hypothesis of Deceleration of Indian Agriculture," *Indian Journal of Agricultural Economics* 38 (1983): 475-491.

[17] *Sarvekshana* 8 (July 1984).

Like the rest of India, Karnataka has more cattle than buffalo—more than 9 million of the former and nearly 3 million of the latter. However, the role of cattle is primarily to supply draft power, as the low percentage of female cattle—49 percent—shows. Though the percentage of crossbred cattle in the total herd was low, promotion in the late 1960s and early 1970s resulted in Karnataka having more crossbred cattle than any other state in India.[18]

A study by the KDDC evaluated changes between a benchmark survey in 1977/78 and one in 1980/81.[19] The study documents a change in herd structure, with the number of local cows decreasing and crossbred cows increasing. Similarly, the total amount of feed used decreased, but use of concentrates increased. Average daily yields did not change, but the average number of days in lactation increased. Most significantly, the net return to farmers did not change. The study concentrates on growth in cooperative membership and does not measure changes in productivity. Nor does the study examine consumption or production and returns for farmers not in cooperatives.

Design of the Current Study

The current study was undertaken in two of the three ecological zones covered by the KDDC—the Maidan South and the Transitional South. Data from five rounds of surveys were collected. These included both stock and flow variables for 806 households. The sample included 21 villages from each of the two agroclimatic zones—42 villages with cooperatives. The principal crops in these villages are irrigated rice and ragi, with twice as much area devoted to the latter. Pulses, groundnuts, sugarcane, and mulberry trees for silk production are also grown in the area. Each zone was stratified into three brackets according to age of the cooperative. Seven villages were randomly chosen from each bracket. A census was taken in each village in order to stratify the sample according to landholding status. In each village, 13 households were randomly chosen—3 each from the landless, small farm, and large farm strata, and 4 from marginal farmers. The total from cooperative villages then is 546 (2 zones × 3 age brackets for cooperatives × 7 villages × 13 households). Twenty villages without cooperatives—10 from each zone—were chosen at random from a list of all villages excluding Dairy Cooperative Society (DCS) villages in each district. Again, a census was undertaken and 13 households were selected from each village according to landholding status.

The actual population weights—that is, the proportions of the population in each village belonging to the various landholding classes—are not available.[20] Averages for the villages or averages within the cooperatives cannot, then, be weighted to represent the average within the sampling universe. This, however, does not imply that the statistics for the subgroups are biased. For example, statistics for milk consumption among landless families should be representative of that subgroup. Moreover, the conclusions of this study are not based on comparisons of village means, but on multivariate regressions, which under standard assumptions are unbiased whether weighted or not.

Two types of potential sample selection bias must be considered. Often the villages included in a study are not truly representative of the set of villages from which they are chosen. A village representing dairy cooperatives may have larger landholdings than the average cooperative or differ by some other characteristics that influence outcome variables. This type of bias is a particular problem for pairwise comparisons.[21] With a relatively large sample of randomly chosen villages and through the use of multivariate techniques, this study reduces such potential bias.

---

[18] Singh, Srinivasan, and Raju, *Project Completion Report.*

[19] H. Sridhara, M. Munegowda, and K. Krishnamurthy, "Part II—Study on the Basic Resources and Potentials of the Dairy Farmer in KDDC Command Area—A Benchmark Survey," *Applied Forage Research and Demonstration in the KDDC Command Area of Karnataka* (Bangalore: University of Agricultural Science, 1983); and H. Sridhara, M. Munegowda, and K. Krishnamurthy, "Part III—Study on the Impact of KDDC Milk Supply Scheme on the Rural Economy in the KDDC Command Area," *Applied Forage Research and Demonstration in the KDDC Command Area of Karnataka* (Bangalore: University of Agricultural Science, 1984).

[20] Population weights have not been found among the papers of the late T. K. Lakshman.

Another type of bias occurs when the set of villages in which cooperatives were established is inherently different from the control group. If, for example, cooperatives are established in the most productive villages, a comparison of randomly drawn villages with and without cooperatives will attribute such differences in production to the presence of the cooperatives when, in fact, they predated it. The absence of baseline data or longer time series in the villages, then, is a potential limitation of the current study. Published data indicate no significant differences in village sizes in the two subsets in the 1981 census, nor any difference in the average growth rates of population between 1971 and 1981. The latter may be a rough indicator of relative economic conditions as migration would presumably be greater out of the villages with fewer economic opportunities. The control and project subsample village population grew between 2.1 and 2.3 percent annually through the decade. While the control villages had a higher percentage of people in the scheduled castes (18.9 percent compared with 15.4), the project group also included one Tibetan refugee village that is probably closer to the scheduled castes in its social position than to more privileged groups.

A comparison of development indicators that predates the project does not support the view that these two sets differ in infrastructure. The percentage of control villages that had schools, electricity, paved roads, or post offices in 1971 is slightly higher than the corresponding percentage in villages that were to receive cooperatives in the subsequent decade.[22] While the average village in the control sample is slightly farther from the nearest town, the average distance is only 2 percent greater than the average for villages with cooperatives.

More precise indicators, such as the amount of milk produced before the project or the number of crossbred cattle at the time of entering the cooperative, are not available. Other comparisons using survey data show no statistically significant differences in the average prices of commodities other than milk or for wages between the two subsamples. General differences in infrastructure would presumably be reflected in such prices. Similarly, the average yields for the principal field crop, ragi, do not differ between the two subsamples.

Data were collected in five quarterly visits between January 1983 and April 1984. During each visit, data were collected on household incomes and total expenditures, incomes from the sale of milk and prices received, foodgrain yields and incomes from the sale of foodgrains and prices received, labor use in dairy production and other agricultural activities, labor input by each household member, use of modern inputs, and other variables. Daily production net of calf feeding was reported for each cow and by animal type. Production was reported for mornings and evenings separately. Cross checks on sales and production were available; the sum of production of individual cows was compared with total production data elsewhere in the survey, and sales plus home consumption was compared with production data.

Farmers reported the amounts of home-produced as well as purchased concentrates, green fodder, dry fodder, and other fodders fed to each animal. Only when a farmer did not know individual feeding rates were data collected by animal type.

Periodic data were also collected on at least two of the following three variables: the quantity of each food commodity consumed by the household, expenditures for each commodity, and the price paid for the commodity. While expenditure data provide a cross check for data entry errors, separately reported price data were the source for prices in the subsequent analysis. Expenditures on home-produced goods were evaluated using the average price in the village in that round. Such expenditures were included in total expenditures.

---

[21] Alderman, Mergos, and Slade, *Cooperative Dairy Development.*

[22] Data are from India, Directorate of Census, *Census of India 1971, District Survey Tables,* various volumes (Bangalore: Directorate of Census, 1973).

By returning to the same farmers in each round, the survey was able to capture specific seasonal and short-term price effects on production and consumption. This survey approach, referred to as panel data, is particularly useful for controlling for unobservable household-specific factors, such as differences in tastes, and is discussed further in Chapter 7.

In addition, stock or inventory data were collected during the first and last visit and included details of farm size. Data pertaining to other agricultural capital, household size, age and sex of household members, and anthropometric measures were also collected. Data on household size were not keypunched from the fourth or the fifth round for a subset of the sample. The size in the fourth round was used instead, where available. Otherwise, the third-round data were used.

4

CONCEPTUAL FRAMEWORK

A useful conceptual framework for viewing the effects of such projects on human nutrition has been devised by Per Pinstrup-Andersen.[23] A dairy scheme or any other agricultural project can influence nutrition through five pathways. Human nutrition can be affected by: changes in the food available locally; changes in a household's ability to obtain food; changes in a household's preference for foods, given availability and purchasing power; changes in the distribution of food within the household; and other changes in the environment that influence health.

These pathways are often complex, and are discussed in greater detail elsewhere. It is useful, however, to place these pathways in the context of the farm household model that implicitly underlies the data analysis already presented.[24]

Such models begin with the assumption that households maximize farm profits given input prices, output prices, capital assets, and human capital. The maximization is subject to the technology embodied in a production function. Such models may be modified to account for risk aversion as well. Households also maximize a utility function that includes food commodities, nonfood commodities, and leisure subject to exogenous income (including transfers and rents), net farm profits, and the value of time.

Note that the availability of a commodity does not enter the standard model directly, nor is the quantity a household produces generally an argument in the utility maximization or budget constraint from which demand equations are derived. Change in availability only enters into the conventional model insofar as it changes prices, that is, the relationship of demand to availability is important.

An agricultural project can affect household food consumption by introducing changes in technology that increase farm profits and, subsequently, food demand. In a general equilibrium framework, such a shift could lead to an increase of the supply of a commodity large enough to lower prices and profits, but such an issue is outside the discussion here. A project may also upgrade managerial skills, which can increase profits. In another vein, a project may have a significant effect on nutrition through asset transfers and, subsequently, profits. Neither Operation Flood nor the Karnataka project, however, transfers farm assets directly. Nevertheless, conditions created by such projects may encourage private investment, which might increase farm profits over time.

Under such a model, the first link between a project and its nutritional outcome is the change in profits the project induced. This comes from changes in productivity as well as changes in input and output prices. Ideally, total farm profits would be studied, because profits from one commodity may change following a reallocation of resources that affect profits from other commodities. In addition to changes in net profits, changes in labor earnings need to be included in the evaluation of the net effects of a project. The net effect on the demand for individual commodities or for nutrients can be calculated using such changes in earnings as well as changes in commodity prices. Furthermore, though nonseparability of consumption and production implies that a farm household model should be estimated simultaneously rather than recursively, a picture of the net effect of a project on nutrition can include the effect of changes in production on the desire to purchase specific foods—that is, on preference ordering.

---

[23] Per Pinstrup-Andersen, "The Impact of Export Crop Production on Human Nutrition," in *Nutrition and Development*, ed. Margaret Biswas and Per Pinstrup-Andersen (Oxford: Oxford University Press, 1985).

[24] Details and variations of such models can be found in Inderjit Singh, Lyn Squire, and John Strauss, eds., *Agricultural Household Models: Extensions, Application, and Policy* (Baltimore, Md.: Johns Hopkins University Press, 1986).

The goals of the research can be presented in terms of hypotheses about income, food prices, and demand preferences. These are presented below in terms of positive effects, although clearly one wants to test the negative effects as well. The components can then be linked together in order to give a picture of the net effect on nutrition. Furthermore, although demand for an individual food commodity is not an accurate indicator of nutrient demand—which itself is only a rough indicator of economic welfare—the net effect on milk consumption will be presented. In part, this is because a narrow concern with milk consumption, rather than nutrient consumption, still appears in a variety of professional and popular publications. For example, an attack on Operation Flood in the press, which apparently gave impetus to a governmental evaluation of the program, lamented that all the milk in the author's village had gone to towns, but expressed no acknowledgment of the rupees earned in what were presumably transactions freely entered into by farm households.[25] Similarly, a recent National Dairy Development Board report on the nutritional effects of Operation Flood acknowledged the importance of emphasizing nutrients rather than milk per se, then went on to present data documenting the relative decline of milk prices in urban centers and the change in the percentage of poor consumers who purchase milk from organized dairies, rather than in the informal sector, as if this data were evidence of nutritional improvements.[26] Furthermore, milk consumption per se is discussed here because of potential implications for pricing policy.

The hypotheses on the effects of the dairy project on income are as follows:

- The project has increased milk production by increasing production per cow or by increasing the size of the herd or by increasing the share of improved cattle types. The first has been achieved either by a shift of the production curve or a decrease in the size of a gap between the actual and optimal allocation of inputs. The second, the increase of the size of the herd, is not in line with the objective of keeping the national milk herd size constant but is a testable hypothesis that may explain any increase in production. The third can be considered a shift in technology embodied in capital.
- The project has either increased income from other farm activities or reduced such income less than any increase in dairy income.
- The project has increased wage earnings either by an increase in real wages or hours employed or both.

The hypotheses on the effects of the project on available food supplies and prices are as follows:

- The project has decreased or had no effect on the cost of food in project sites.
- In particular, the project has had no effect on the retail price of milk or milk products.
- The project has not created market disequilibria or forced sales. Observed sales of milk, then, reflect market mechanisms and not coercion. In the absence of such extra market effects, sales can be assumed to represent a farm household's optimization of consumer decisions given production possibilities.

The hypotheses on the effects on the desire to purchase nutrients are as follows:

- The project has had no effect on the propensity to purchase calories, controlling for income, or on the propensity to purchase protein, again, controlling for income.
- The project has had no effect on the propensity to consume milk.

---

[25] C. Alvares, "Operation Flood: The White Lie," *Illustrated Weekly of India* (October 30, 1983), pp. 8-13.

[26] National Dairy Development Board, *Nutritional Impact of Operation Flood* (Anand: NDDB, 1983).

5

MILK PRODUCTION

Sometimes the reviewer of a book or a movie leaks the outcome of the story. With a good plot, however, knowledge of the final outcome need not detract from the enjoyment of the piece. Here Table 1 serves as such an indiscreet review. It reveals that households in villages organized into cooperatives produce appreciably more milk than their counterparts in the control villages. The rest of this chapter explores this difference and seeks to determine whether the outcome has policy implications or is merely an ironic twist of the basic story line.

The data in Table 2 illuminate this difference in production. They indicate that the composition of production by animal types differs markedly in the two groups of communities. Local cows actually produced more milk and buffalo only slightly less milk in the control villages than in the DCS villages. Households in the cooperative villages, however, reported that crossbred cows produced appreciably more milk. As can be seen, however, yields per lactating animal differ only slightly between the two communities. Much of the difference in production comes from differences in animal holdings and, to a lesser degree, in differences in length of lactation.

Conclusions from a comparison of group means may, of course, be misleading if the

Table 1—Daily household milk production, January 1983-April 1984

Round/Period	Cooperative Villages	Control Villages
	(liters/day)	
Round 1 (January-April 1983)	3.61 (0.20)	1.80 (0.18)
Round 2 (May-July 1983)	2.56 (0.17)	1.57 (0.16)
Round 3 (August-October 1983)	2.95 (0.19)	1.57 (0.17)
Round 4 (November 1983-January 1984)	3.07 (0.19)	1.93 (0.19)
Round 5 (March-April 1984)	2.91 (0.18)	1.77 (0.18)

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.

Note: The numbers in parentheses are the standard errors of means.

Table 2—Milk yields per lactating animal and daily milk production, by animal type, January 1983-April 1984

Production or Yield/Animal Type	Cooperative Villages	Control Villages
	(liters/household/day)	
Production		
Local cows	0.48 (0.02)	0.54 (0.03)
Buffalo	1.08 (0.03)	0.88 (0.05)
Crossbred cows	1.46 (0.08)	0.31 (0.05)
	(liters/lactating animal/day)	
Yield		
Local cows	1.54 (0.05)	1.39 (0.04)
Buffalo	1.86 (0.03)	1.85 (0.06)
Crossbred cows	5.79 (0.15)	5.78 (0.49)

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.

Note: The numbers in parentheses are the standard errors of means.

populations are not closely matched. By illustration, note that production per household differs by landownership class (Table 3). If landownership or other factors differ between the two communities, then the differences in production may be attributable to such factors rather than to the cooperative structure per se. Accordingly, the main part of this analysis will employ multivariate analysis to explore in detail the differences in production.

Table 3—Milk production by landholding category, January 1983-April 1984

Landholding Category	Size of Landholding	Production
	(hectares)	(liters/household/day)
Landless	0	1.47 (0.08)
Marginal farm households	0-1.01	1.86 (0.12)
Small farm households	1.01-2.02	2.77 (0.13)
Other farm households	More than 2.02	4.54 (0.18)

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.

Note: The numbers in parentheses are the standard errors of means.

As a first step, the differences observed in Table 1 should be tested statistically, controlling for a number of relatively exogenous variables.[27] To do this, household milk production is regressed on characteristics of the household (the age of the head of the household, the education of the household head, household size, and the proportion of children under five in the household, who are, presumably, not available for herding) and of the farm (landholding categories and ownership of a well). In addition, a dummy variable for residence in the control villages (which have no dairy cooperatives) is included. The results, using a tobit regression to account for the special properties of the limit on negative values in the sample, are shown below:

$$
\begin{aligned}
\text{Total Milk Production} = & -3.37 + \underset{(0.00170)}{0.00133\,\text{Agehead}} \\
& + \underset{(0.083)}{0.405\,\text{HHsize}} - \underset{(2.18)}{6.01\,\text{Cshare}} \\
& + \underset{(0.460)}{1.73\,\text{Literacy}} + \underset{(0.864)}{0.029\,\text{Matriculate}} \\
& - \underset{(0.884)}{2.53\,\text{Landless}} - \underset{(0.787)}{1.07\,\text{Marginal}} \\
& + \underset{(0.873)}{1.789\,\text{Large Farm}} + \underset{(0.717)}{1.15\,\text{Well}} \\
& - \underset{(0.762)}{0.508\,\text{Dry Season}} - \underset{(0.650)}{2.56\,\text{Control}}, \qquad (1)
\end{aligned}
$$

where

Total Milk Production = the daily household milk production in each round,

Agehead = the age of the household head in months,

HHsize = the number of household members,

Cshare = the percentage of household members under age five,

Literacy = a dummy variable defined as one if the household head is literate,

Matriculate = a dummy variable defined as one if the household head has finished 10th grade,

Landless = a dummy variable defined as one if the household owns no land,

Marginal = a dummy variable defined as one if the household has a landholding less than 1 hectare,

Large Farm = a dummy variable defined as one if the household owns more than 2 hectares,

Well = a dummy variable defined as one if the household owns a well,

Dry Season = a dummy variable defined as one if the observation was taken between May and July 1983, and

Control = a dummy variable defined as one if the household resides in a control village (one with no dairy cooperative).

(The numbers in parentheses are standard errors.)

---

[27] The phrase "relatively exogenous" may appear contradictory, but inasmuch as variables that are frequently presumed to be exogenous—for example, family size, land ownership, and village residence—may reflect household decisions, the concept of exogeneity may admit relative positions.

Households that are larger or literate or have larger landholdings produce more milk. A higher education has no additional effect. Production is higher when the family owns a well, although this relationship may not be directly causal. The decline of production in the dry season is not significant.

The results show that the households of the control population produced significantly less milk than the residents of villages with cooperatives. Somewhat surprisingly, in another regression (not shown), the additional effect of membership in the cooperative, beyond the effect of the presence of the cooperative in the village, is lower rather than higher production. Only 7 percent of the sample households within villages organized into cooperatives, however, are not members. Since many of the benefits of the cooperatives, particularly the presumed advantage of a reliable market for milk, can be obtained without actual membership, a fair assessment of the effect of the cooperative should include the nonmembers residing in the cooperative villages as beneficiaries, directly or otherwise, of the system. The regression reported in equation (1) indicates that the average household in the cooperative villages produces nearly twice as much milk per day, controlling for other variables.[28] This difference is significant at a probability of error less than 0.001. In a separate regression, no significant difference was observed between older and more recently established cooperatives.

Although statistically significant, such differences in levels of production do not explain the structure of those differences or aid much in program design. Accordingly, it is useful to view the total production per household as a product of three components—the size of the herd, the probability that cows in the herd are lactating, and the yields of lactating cows. Furthermore, if each type of dairy animal is considered separately, total production is the sum of the production for each type of animal. In shorthand notation:

$$\text{Total Milk Production} = \Sigma_i\, [A_i(L_i/A_i)(Q_i/L_i)], \qquad (2)$$

where

A_i = the number of animals of type i that are maintained,

L_i = the number of lactating animals, and

Q_i = the quantity of milk produced per day.

Conceptually, the analysis of herd composition can be broken into the decision to maintain a herd and the subsequent herd stocking conditional on that decision. It does not appear warranted in this sample, however. Few households failed to maintain a herd at one time or another during the 15 months of the survey. But in a number of subsequent regressions, an appreciable proportion of the sample had values of zero for the dependent variable or the regressions were performed on truncated samples—for example, only cows in milk were used to estimate productivity.

Regressions using such samples must take account of these special properties.[29] In the analyses below both probit and tobit estimations are used to correct for biases that would be introduced if ordinary least squares (OLS) estimations were made. Familiarity with such econometric techniques, however, is not necessary for the reader to interpret the regression results presented.

Herd Size

The average household in the cooperative community had a herd of 5.5 cows and buffalo in September 1983, of which 28 percent were males or neutered. The milch herd was 36 percent local cows, 17 percent crossbred cows, and 47 percent buffalo. The control community had a somewhat smaller herd of 4.7 animals, 71 percent of which were milch animals. This milch herd was composed of 51 percent local cows, 5 percent crossbred cows, and 44 percent buffalo.

---

[28] A variable obviously missing is the price of milk. Curiously, the variable had an unexpected negative and statistically significant sign even when deflated by a price index. Perhaps the variable should be lagged, although the data do not allow for a detailed investigation of long-run effects. The coefficient indicating the impact of the cooperative changed little with such an alternative model. Distance to the nearest town was not significant in earlier estimates. As this distance variable is missing for a few villages not reported in the district census, it is not used in the subsequent analysis.

[29] See George Maddala, *Limited Dependent and Qualitative Variables in Econometrics* (Cambridge: Cambridge University Press, 1983).

Regressions explaining herd size are shown in Table 4. Households in cooperative communities maintain significantly more crossbred cows and buffalo and fewer of the indigenous type of cows than the control group. The reduction of the number of the local stock is in keeping with the goal of Operation Flood to increase milk production by changing the composition of the national herd, but not its size. However, the net effect indicates that households in cooperatives have significantly larger herds. This is due mainly to a large increase in buffalo rather than in crossbred cattle as planned in the project. While literacy correlates with the number of buffalo maintained, higher education seems to be important only in the case of crossbred cows Total herd size increases with the size of landholdings and households.

If the cooperative encourages or facilitates investing in cattle, such investment might be cumulative. Accordingly, regressions were run with dummy variables to test the differences between households in villages with newly established cooperatives, those where the DCS had operated between two and four years, and those where the cooperatives were older (Table 4). While the number of buffalo increases progressively with the age of the cooperative (with the newer cooperatives not being significantly different than the control community), a curious pattern is observed in the regressions explaining crossbred cattle. It appears that farms in the newer cooperatives enthusiastically adopt crossbred cattle, but progressively disinvest in these animals as the cooperative matures. (The first subpopulation is significantly different from the others at the 5 percent level. The second is different from the third at the 10 percent level.) This may reflect some drawbacks of owning crossbred cattle, which, if widespread, have serious implications for the dairy development strategy in the region. There are no significant differences between the cooperative subgroups in the regressions with total herd size as the dependent variable.

Although a cross between exotic and local breeds can outperform local stock, successive crosses present difficulties. More than half of second-generation calves that are 75 percent exotic do not live long enough to produce milk,[30] whereas cows that are 25 percent exotic have little if any advantage over local breeds. Early in their experience with crossbred cattle, then, farmers learn that they must either purchase calves or maintain local breeds for replenishing their herds. This, plus the possibility of low-value or high-risk progeny being born to crossbred cows, may discourage farmers.

Although bullocks are only of peripheral concern in this study, the regression concerning the number of bullocks is of some note. The relationship to landholding is, of course, expected. So is the relationship to household size. Since 86 percent of the bullock population were local bovines, it is noteworthy that there were no fewer bullocks in the cooperatives than in the control community, although there were significantly fewer local cows.[31]

Percent of Animals in Lactation

The probability that a cow or buffalo will be lactating at any given time reflects both the breeding success and the duration of lactation following a calving. The biological endowment of the animal, including breed and age, is important, of course. However, management is also important in order to maintain proper nutrition, recognize es-

---

[30] R. E. McDowell, "Crossbreeding in Tropical Areas with Emphasis on Milk, Health, and Fitness," *Journal of Dairy Science* 9 (No. 68, 1984): 2418-2435.

[31] For this regression, any nonfemale animal was included as a bullock.

Table 4—Tobit regressions explaining the number of animals stocked, January 1983-April 1984

Independent Variables	Dependent Variables								
	Cows	Cross-breds	Buffalo	Milk-Herd Size	Cows	Cross-breds	Buffalo	Milk-Herd Size	Bullocks
Intercept	1.5397	−4.0601	0.8824	1.0569	2.0906	−6.4278	0.4708	0.5225	0.7778
	(0.4335)	(0.4259)	(0.4244)	(0.2615)	(0.4381)	(0.4690)	(0.4307)	(0.2531)	(0.2942)
Agehead	−0.0057	0.0014	−0.0061	0.0007	−0.0025	0.0011	−0.0061	0.0006	−0.0055
	(0.0005)	(0.0005)	(0.0005)	(0.0003)	(0.0005)	(0.0005)	(0.0005)	(0.0003)	(0.0004)
Household size	0.2306	0.1272	0.2711	0.3462	0.2331	0.1318	0.2675	0.3455	0.3028
	(0.0272)	(0.0239)	(0.0265)	(0.0107)	(0.0273)	(0.0237)	(0.0265)	(0.0158)	(0.0213)
Cshare	−0.8439	−0.2454	−2.1678	−2.6580	−0.8265	−0.3400	−2.1255	−2.8159	−1.9959
	(0.7169)	(0.6698)	(0.7049)	(0.4509)	(0.7167)	(0.6645)	(0.7039)	(0.4125)	(0.5639)
Literacy	−0.1531	0.1920	0.9611	0.5861	−0.1572	0.1666	0.9813	0.5629	0.5249
	(0.2102)	(0.1967)	(0.2058)	(0.1318)	(0.2102)	(0.1954)	(0.2056)	(0.1188)	(0.1620)
Matriculate	−0.0743	1.6096	−0.1064	0.1997	−0.0824	1.6953	−0.1392	0.2153	−0.6126
	(0.3018)	(0.2542)	(0.2890)	(0.1441)	(0.3018)	(0.2521)	(0.2888)	(0.1723)	(0.2349)
Landless	−1.4509	−1.1603	−0.2971	−1.4897	−1.4428	−1.1717	−0.3080	−1.5080	−1.4242
	(0.2929)	(0.2736)	(0.2848)	(0.1860)	(0.2927)	(0.2716)	(0.2844)	(0.1645)	(0.2256)
Marginal	−0.7382	−0.9255	−0.5369	−1.0245	−0.7368	−0.9507	−0.5307	−1.0360	−0.9090
	(0.2620)	(0.2397)	(0.2585)	(0.1737)	(0.2618)	(0.2381)	(0.2581)	(0.1475)	(0.2009)
Large farm	1.3520	0.0974	2.0405	1.8866	1.3472	0.0671	2.0488	1.8745	1.8142
	(0.2811)	(0.2439)	(0.2735)	(0.1425)	(0.2808)	(0.2420)	(0.2731)	(0.1601)	(0.2154)
Well dummy	−0.6004	0.2733	0.6006	0.1020	−0.5856	0.3291	0.5916	0.1022	0.0805
	(0.2284)	(0.1979)	(0.2194)	(0.1217)	(0.2282)	(0.1964)	(0.2189)	(0.1284)	(0.1753)
Control dummy	0.5363	−2.7315	−0.4416	−0.6792	. . .	. . .	. . .	. . .	. . .
	(0.2053)	(0.2280)	(0.2031)	(0.1201)					
Year coop dummy	. . .	. . .	. . .	. . .	−0.7967	3.0159	0.1011	0.5187	−0.3326
					(0.2619)	(0.2575)	(0.2569)	(0.1485)	(0.2055)
2-4 year coop dummy	. . .	. . .	. . .	. . .	−0.4363	2.4554	0.5204	0.7115	0.3021
					(0.2594)	(0.2588)	(0.2545)	(0.1478)	(0.2022)
Over 4-year coop dummy	. . .	. . .	. . .	. . .	−0.6860	2.0793	0.7898	0.6004	0.1872
					(0.2636)	(0.2613)	(0.2564)	(0.1496)	(0.2048)

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.

Notes: Variable names are the same as in equation 1. The numbers in parentheses are standard errors.

trus, and provide a proper sire. The percentage of cows in lactation at any given time is also influenced by culling practices. In the model used to get the regression results reported in Table 5, management was proxied by the education of the herd owner and by the presence of a dairy cooperative. As current herd size may reflect culling practices, the size of the herd in the previous survey round was used to investigate scale effects. The unit of observation was the individual cow. Probit regressions were used rather than OLS.

As expected, the probability of lactation is strongly conditioned by the animal's age, with an apparent peak in probability of lactation, calculated from the quadratic terms, being between the ages of 96 and 108 months (Table 5). No other variable had a consistent effect; buffalo in the control group were somewhat more likely to be giving milk, but the opposite was observed with crossbred cows. Similar mixed results were observed for higher education and farm size, while no effects of herd size were apparent.

In a combined regression (not reported in Table 5), the coefficients of the dummy variables for crossbred cattle and for buffalo were both positive and highly significant, indicating that these animals are more likely to be in lactation than local cows. Moreover, the probability of lactation was also significantly higher for crossbred cows than for buffalo. This combined regression verifies differences between animal types, but the restrictions necessary for pooling the equations were rejected. In the combined regression, the net effect of the variable for the control community was not significant. As education was also not significant, it appears

Table 5—Probit results for probability of lactation, January 1983-April 1984

Independent Variable	Local Cows	Buffalo	Crossbred Cows
Intercept	−3.25	−3.35	−2.95
Cow age	0.056 (0.003)	0.068 (0.003)	0.081 (0.005)
Cow age^2	−0.00026 (0.00002)	−0.00032 (0.00002)	−0.00043 (0.00004)
Literacy	0.0045 (0.005)	−0.0087 (0.051)	0.106 (0.093)
Matriculate	0.251 (0.082)	−0.160 (0.076)	−0.087 (0.119)
Dry season	0.035 (0.051)	0.080 (0.047)	0.110 (0.087)
Landless	0.194 (0.080)	0.086 (0.072)	−0.126 (0.138)
Marginal	0.117 (0.067)	0.211 (0.066)	−0.082 (0.118)
Large farm	0.025 (0.061)	−0.021 (0.055)	0.108 (0.099)
Well ownership	−0.021 (0.052)	0.019 (0.044)	−0.079 (0.087)
Lagged herd size	0.0003 (0.004)	−0.0016 (0.004)	0.0027 (0.008)
Control dummy	0.062 (0.052)	0.083 (0.051)	−0.306 (0.130)

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.
Note: The numbers in parentheses are standard errors.

that biological endowment was not appreciably augmented by education or management in the communities studied.

Milk Production Curves

It is of interest to observe whether the technical relationships transforming feed inputs into milk differ between cows in control and dairy cooperative households. It is plausible that management techniques differ so that output *at a given level of input* differs. A dummy variable for literacy is often included in production functions as a proxy for management. In the regressions reported in Table 6, a dummy variable for the control community was included to test the hypothesis that management, hence output per amount of inputs, differed in the two groups. Such regressions were made by animal type when the respondent was able to distinguish the feed given to the different breeds. Production was per lactating animal and inputs were per animal. A pooled regression (not reported) was also estimated, but the restrictions implied by such a pooling were rejected.

Only a few variables in the regressions had consistent and significant effects. Productivity was consistently lower in the dry season. The elasticity of purchased concentrates was statistically significant and positive and greatest for crossbred cows. It was also greater than the elasticities for home-produced concentrates, which were positive but not significant. While the coefficient of labor was positive and significant for cows, it was not significant in the other regressions. The coefficient of pasture hours was consistently negative and dry fodder was negative or not significant in each regression. These coefficients, then, were less than reliable for estimates of the marginal productivity of inputs, but the primary concern for their inclusion here was to prevent missing variable bias of the coefficient for the control community.[32]

There is no evidence in the sample to support the hypothesis that the dairy cooperatives increase productivity per lactating animal. Indeed, it appears that the productivity of crossbred cows was higher in the control population. Given that this appears to have been the case in each of the three subcategories of cooperatives grouped by age, containing 14 cooperatives each, this is unlikely to have been an artifact introduced by special conditions in some cooperative villages. Those few farmers in the control villages that adopted crossbred cattle represent the most progressive farmers in that community. They may have better management skills than the average farmer in the larger group of crossbred owners in the cooperative villages.

One other item of note in these regressions is that crossbred or local cows owned by the landless were significantly less productive than those owned by small farmers. The reverse is true for buffalo. The landless have larger herds of buffalo than small farmers, but smaller herds of two categories of cows. An econometric refinement, beyond the scope of this research, would analyze productivity and herd size as jointly determined.

Input Demand

It is possible that both communities are on the same production curve but use different amounts of inputs. This could lead to differences in production. Such differences might reflect differences in input prices or imperfections in markets not indicated by such prices. They may also reflect differences in attitudes toward risk or differences in allocative efficiency with risk aversion

---

[32] Regressions were also performed using data for those cows for which individual feed levels were known. These regressions included variables for the age of the animal and time since calving, as well as the reported value as a proxy for genetic stock. (This latter variable had virtually identical coefficients for each animal type.) A Heckman procedure, from James Heckman, "Sample Selection Bias as a Specification Error," *Econometrica* 47 (January 1979): 153-162, was used to account for any bias introduced by selection of lactating cows. The basic results do not differ from those reported in Table 7. In these regressions, however, dry fodder had small positive elasticities significant at the 10 percent level.

Table 6—Coefficients of production functions, January 1983-April 1984

	Dependent Variable					
	Model 1			Model 2		
Independent Variable	L Prod (Local Cows)	L Prod (Buffalo)	L Prod (Crossbred Cows)	L Prod (Local Cows)	L Prod (Buffalo)	L Prod (Crossbred Cows)
Intercept	−0.220	0.670	1.800	−0.240	−0.690	2.170
L fodder	0.114 (0.082)	−0.082 (0.056)	−0.318 (0.094)	0.122 (0.082)	−0.087 (0.057)	−0.311 (0.094)
L home-produced concentrate	0.014 (0.015)	0.010 (0.010)	0.034 (0.022)	0.014 (0.015)	0.010 (0.010)	0.031 (0.022)
L purchased concentrate	0.060 (0.017)	0.053 (0.012)	0.207 (0.027)	0.057 (0.017)	0.053 (0.012)	0.217 (0.028)
L pasture hours	−0.123 (0.041)	−0.016 (0.020)	−0.071 (0.020)	−0.133 (0.041)	−0.017 (0.020)	−0.068 (0.020)
L labor	0.169 (0.075)	0.002 (0.052)	−0.001 (0.072)	0.182 (0.075)	0.003 (0.052)	−0.004 (0.072)
Literacy	0.050 (0.075)	−0.040 (0.050)	−0.087 (0.093)	0.043 (0.067)	−0.039 (0.051)	−0.096 (0.094)
Dry season	−0.394 (0.083)	−0.373 (0.059)	−0.369 (0.114)	−0.395 (0.083)	−0.373 (0.059)	−0.361 (0.114)
Landless	−0.209 (0.102)	0.123 (0.071)	−0.351 (0.140)	−0.223 (0.103)	0.124 (0.072)	−0.376 (0.140)
Marginal farms	−0.195 (0.088)	0.126 (0.065)	−0.146 (0.127)	−0.203 (0.088)	0.125 (0.065)	−0.162 (0.128)
Large farms	−0.089 (0.100)	0.003 (0.071)	0.067 (0.120)	−0.096 (0.100)	0.001 (0.071)	0.068 (0.120)
L herd size	0.329 (0.132)	0.037 (0.095)	0.078 (0.137)	0.342 (0.182)	0.037 (0.095)	0.086 (0.137)
Well ownership	−0.136 (0.082)	0.069 (0.052)	−0.038 (0.096)	−0.120 (0.082)	0.068 (0.053)	−0.050 (0.099)
Control dummy	0.031 (0.066)	0.024 (0.045)	0.350 (0.150)	. . .	. . .	. . .
Under 2-year coop dummy	. . .	. . .	. . .	−0.168 (0.089)	−0.035 (0.067)	−0.403 (0.159)
2-4-year coop dummy	. . .	. . .	. . .	0.015 (0.094)	−0.016 (0.067)	−0.202 (0.166)
Over 4-year coop dummy	. . .	. . .	. . .	0.027 (0.087)	−0.021 (0.064)	−0.434 (0.169)
Degrees of freedom	477	795	265	475	793	263
R^2	0.15	0.10	0.35	0.15	0.10	0.36

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.

Notes: L fodder, L home-produced concentrate, L purchased concentrate, L pasture hours, and L labor are the logs of the daily use of the respective inputs per animal. L Prod is production per lactating animal. L herd size is the log of the total number of milch animals owned. The other variables are defined in the text. The numbers in parentheses are standard errors.

held constant. A full analysis of such issues goes beyond the nature and quality of the data available, but a glance at Table 7 is enough to indicate that there were differences in the amounts of feed used that deserve investigation.

For example, there were major seasonal differences in input use, particularly for green fodder and dry fodder, although changes in the use of concentrates were also observed.[33] This may reflect the seasonality of the monsoon that began in July, though pasture hours, surprisingly, show no seasonal pattern. The pattern discernible in the use of other feeds is hard to explain. It is conceivable that the definition of home-produced concentrates was changed during the survey without any documentation being recorded.

Both communities reported a moderate amount of labor per animal—155 minutes daily in the cooperative villages and 164 in the other villages. This includes herding time, usually by children, as well as gathering fodder, milking, and marketing the milk. No differences in the reported ratio of hired to total labor were observed. In the control community, 15.3 percent of the labor was hired while 15.1 percent was hired where cooperatives were present. A regression of agricultural wages against time and a dummy variable for the control community indicated a significant rise in wages over the study period but no differences in the average wage in the two communities.

It should be recalled that herd composition in the two communities differs. This is a probable explanation for the differences in use of concentrate between the cooperative and control groups; an average of more than a kilogram of purchased concentrates was fed daily to crossbred cattle over the five survey rounds. Accordingly, the multivariate regressions to test for differences in input use reported in Table 8 were run by animal type. A test for pooling rejected the restrictions that such a pooling implies. However, inasmuch as labor is often collectively applied to the total herd, the regression for labor inputs is by herd rather than by animal type.[34] As no zero values were

Table 7—Daily feed inputs per animal, January 1983-April 1984

Period/Type of Village	Green Fodder	Dry Fodder	Purchased Concentrates	Home-Produced Concentrates	Other Feed	Pasture
			(kilograms/day)			(hours/day)
January-April 1983						
Cooperative villages	2.22	4.55	0.89	1.51	0.08	3.31
Control villages	0.96	5.20	0.57	1.64	0.14	4.36
May-July 1983						
Cooperative villages	2.20	4.02	0.19	0.65	0.34	3.40
Control villages	1.61	4.10	0.14	0.51	0.26	3.70
August-October 1983						
Cooperative villages	9.06	1.15	0.40	0.40	2.31	3.23
Control villages	8.30	1.09	0.19	0.04	2.39	4.14
November 1983-January 1984						
Cooperative villages	6.19	4.55	0.44	0.16	3.27	3.51
Control villages	5.30	4.71	0.18	0.15	3.04	4.12
March-April 1984						
Cooperative villages	1.34	7.19	0.40	0.26	3.36	3.46
Control villages	0.98	7.67	0.34	0.16	3.42	3.72

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.

---

[33] Green fodder and dry fodder were combined in the production function of Table 6 on the basis of dry matter equivalents.

[34] Production functions similar to those presented in Table 6 were run with predicted rather than observed inputs. While production elasticities in these equations differ from the reported values, the coefficients of the control variables do not change.

Table 8—Coefficients from the feed demand equations, January 1983-April 1984

Independent Variable	Purchased Concentrates			Fodder[b]			Home-Produced Concentrates			L Labor Per Animal (Total Herd)	
	Cows[a]	Buffalo[a]	Cross-breds[a]	Cows	Buffalo	Cross-breds	Cows[a]	Buffalo[a]	Cross-breds[a]	Model 1	Model 2
Intercept	1.9784	7.6475	7.4758	−3.7510	−0.1663	−11.933	22.496	22.162	16.473	7.9319	9.0865
	(4.644)	(2.948)	(3.163)	(1.157)	(1.043)	(2.294)	(4.422)	(4.065)	(8.812)	(0.5369)	(0.4885)
AgeHead	−0.0035	−0.0029	−0.00006	−0.00001	0.0002	0.0002	−0.0021	−0.0031	−0.0035	−0.00001	−0.00005
	(0.0008)	(0.0005)	(0.0005)	(0.0002)	(0.0002)	(0.0004)	(0.0007)	(0.0006)	(0.0015)	(0.00008)	(0.00008)
Household size	0.0122	−0.0012	0.0514	0.0007	−0.0082	−0.0270	0.0569	−0.0257	−0.1112	−0.0317	−0.0151
	(0.0426)	(0.0300)	(0.0235)	(0.0110)	(0.0108)	(0.0171)	(0.0388)	(0.0391)	(0.0650)	(0.0046)	(0.0042)
Cshare	1.9307	0.3048	−0.6233	−3.8891	−0.2663	−0.1711	0.3435	0.5726	−0.8889	0.1466	0.8173
	(1.067)	(0.6604)	(0.5922)	(0.2835)	(0.2432)	(0.4304)	(1.003)	(0.8737)	(1.564)	(0.1099)	(0.09929)
Literacy	−0.0086	−0.2535	0.1139	−0.0244	0.0324	0.1452	−0.2070	0.1529	−0.1342	−0.0756	−0.0668
	(0.3061)	(0.1863)	(0.1854)	(0.0774)	(0.0656)	(0.1339)	(0.2785)	(0.2452)	(0.4985)	(0.0306)	(0.0276)
Matriculate	−0.1385	0.2053	0.4972	0.1676	−0.0203	−0.0736	0.1047	0.1266	0.2326	−0.0199	0.0071
	(0.4708)	(0.2826)	(0.2271)	(0.1210)	(0.1032)	(0.1653)	(0.4295)	(0.3707)	(0.5973)	(0.0456)	(0.0412)
Landless	0.8755	0.1296	0.5508	0.0806	0.1775	−0.3224	−0.2510	−0.1171	−0.6390	0.2128	0.1835
	(0.4415)	(0.2493)	(0.2430)	(0.1113)	(0.0892)	(0.1761)	(0.4009)	(0.3352)	(0.6577)	(0.0428)	(0.0386)
Marginal	0.7018	−0.1997	0.7198	−0.0828	0.0013	−0.2615	−0.2225	0.1931	−0.2664	0.1253	0.0818
	(0.3839)	(0.2347)	(0.2191)	(0.0951)	(0.0832)	(0.1593)	(0.3420)	(0.3100)	(0.5875)	(0.0380)	(0.0344)
Large farms	0.0946	−0.2208	−0.1973	0.1326	−0.1020	−0.0618	0.2108	0.4313	0.2388	−0.2691	−0.0996
	(0.4318)	(0.2564)	(0.2181)	(0.1061)	(0.0911)	(0.1568)	(0.3772)	(0.3348)	(0.5704)	(0.0412)	(0.0383)
Well ownership	0.6543	0.3831	0.5159	0.1009	0.0846	0.0967	−0.2044	−0.3471	−0.1316	−0.0233	−0.0052
	(0.3469)	(0.1910)	(0.1747)	(0.0888)	(0.0697)	(0.1267)	(0.3189)	(0.2515)	(0.4671)	(0.0322)	(0.0291)
Dry season	−0.8645	−0.6276	−1.1182	−0.5499	−0.7463	−0.0053	−0.3950	0.2002	−0.0330	−0.1549	−0.1532
	(0.4081)	(0.2370)	(0.2105)	(0.0981)	(0.0831)	(0.1489)	(0.3520)	(0.2939)	(0.5384)	(0.0359)	(0.0323)
Percent lactating animals	0.6513	1.1925	1.2507	1.0641	0.8379	0.9006	0.5758	0.1988	0.7224	0.7138	−0.2182
	(0.5992)	(0.3356)	(0.3321)	(0.1550)	(0.1196)	(0.2419)	(0.5554)	(0.4497)	(0.8889)	(0.6347)	(0.0756)
Log ragi price	−0.7889	4.4397	3.0448	2.1911	−1.6525	1.4654	6.7245	6.5650	−2.7879	0.3092	0.1263
	(2.453)	(1.758)	(1.898)	(0.6161)	(0.6089)	(1.369)	(2.321)	(2.248)	(5.025)	(0.2671)	(0.2413)
Log milk price	−8.9269	−3.5822	−4.1602	4.3569	5.6190	1.7431	−8.0366	−8.4870	2.6821	−1.2643	−1.1764
	(3.236)	(2.115)	(2.073)	(0.7871)	(0.7607)	(1.496)	(2.842)	(2.7690)	(5.423)	(0.3308)	(0.2986)

(continued)

Table 8—Continued

Log wage	3.4528	−4.3065	−3.5429	0.2034	−1.8065	6.7661	−11.561	−10.713	−8.7162	−1.5482	−1.5945
	. . .	(2.475)	(2.4450)	(0.9734)	(0.8648)	(1.760)	(3.681)	(3.303)	(6.620)	(0.4162)	(0.3757)
Percent buffalo	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.1893	0.1716
										(0.0319)	(0.0288)
Log herd size	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	−0.5893
											(0.0312)
Control	−0.7110	−0.1468	−0.2217	0.1747	0.0583	−0.0238	−0.4817	−0.4869	−0.0943	−0.01674	−0.0186
	(0.3201)	(0.2169)	(0.2641)	(0.0777)	(0.0753)	(0.1896)	(0.2872)	(0.2873)	(0.7029)	(0.0331)	(0.0299)

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.

Note: The numbers in parentheses are standard errors.

[a] These are Tobit regressions.

[b] Fodder is dry and green fodder combined on a dry matter basis.

valid for labor inputs, the logarithm of labor was used as the dependent variable. Such a transformation allows for direct estimation of wage and scale elasticities.

There are few regular results in Table 8. The control community differed in its input use in four cases; they used a smaller amount of concentrates for cows and of home-produced concentrates for cows and buffalo but more fodder for cows. In the other regressions, no significant differences between the communities were observed. There was likely, then, to be a small effect on total production due to differences in input use.

Literacy did not affect input use, although high school graduates used more concentrates on crossbreds and less labor (hired and household). Total labor inputs were also strongly related to farm size. There also is some evidence that landless and marginal farmers purchase more concentrates than other farmers. Most farmers also reduced inputs in the dry season.

Price effects were, frankly, too erratic to be plausible. This was particularly true for home-produced concentrates, but as mentioned, there is a time trend in the usage of such concentrates that correlates with the trend in prices. The trend in use of this input may, however, actually have reflected a change in the definition of the variable by the field staff. Finally, note that fodder inputs and concentrates increased when animals were lactating.

At this point it is useful to briefly summarize the results in this chapter. A significantly higher level of milk production is observed in the cooperative villages. This can be attributed to increases in the numbers of crossbred cows and of buffalo. There was no observable effect on production per animal or on lactation rates and only a slight effect on feeding rates attributable to the presence of a cooperative. Labor, the use of which is often presumed to increase with the presence of cooperatives, did not differ in the two communities in terms of labor per animal. The effect on total labor use, then, came only from the increase in herd size and the shift of composition. As there were apparently strong scale effects—with larger herds the labor per animal declined—the net effect on labor use was small.

This modest effect on labor is somewhat out of keeping with the conventional wisdom on dairying. However, the concern here is with the additional labor necessary to increase herd size and to maintain improved breeds, taking into account actual village practices rather than recommended levels of inputs. The project led to an increase of only 0.39 milch animals per farm household. Moreover, many activities, such as carrying milk to the collection center or taking animals to pasture, do not require more labor as herd size increases. These two factors account for the small increase in labor. This observation, however, does not belie the premise that the adoption of dairying as a household activity provides new and profitable activities for household members, particularly landless and marginal rural households. The data here were not conducive to a study of the effects of adoption of dairying as opposed to intensification.

Little land was devoted to fodder production—less than 4 hectares over the entire sample in any given round. Dairying, then, did not directly influence cropping patterns. Furthermore, with no observed effect of the project on wages or other input prices and only a small increase of household labor employed directly in milk production, there is no reason to anticipate changes in nondairy farm profits due to the introduction of the cooperatives. While other linkages are conceivable—for example, the effects if more manure were available or cash flow were to improve—the unavailability of adequate data to investigate total farm profits does not appear to be a serious obstacle to investigating the project's effect on household food consumption.

6

MILK MARKETING

Although Chapter 5 indicates that the cooperatives have helped increase production by encouraging the adoption of crossbred cows, a more visible role of dairy cooperatives, one perhaps more intrinsic to them, is in marketing. While the regressions presented in Chapter 5 were not able to measure a convincing producer response to milk prices, increases in production following increases in farmgate prices are plausible. Similarly, dairy development should affect consumer demand through prices; prices affect demand directly through commodity substitution and indirectly through the income of producers. Consequently, this chapter begins with an investigation of prices in the study area and then discusses the marketing patterns of milk producers.

Milk Prices in the Study Area

One of the most satisfying forms of market development would be a scheme that raised producer prices without raising consumer prices through reductions in marketing margins. Operation Flood and the Karnataka project have such intentions. While there is much rhetoric giving middlemen the responsibility for large price spreads, there is little evidence that milk marketing is not competitive. Nevertheless, there are economies of scale in marketing that are available to cooperatives. In general, such changes in marketing costs are more likely to lower consumer prices in the final urban markets than in rural markets. Indeed, since prices offered in rural areas are essentially the market clearing price in the major consuming region (usually urban) minus transport costs, lower marketing costs could raise prices in rural areas.

The regressions in Table 9 examine both producer and retail milk prices.[35] The control villages paid lower prices for both cow and buffalo milk, although only the latter was significantly lower at a 5 percent level of significance. The producers in the control community also received a lower price for their production. Furthermore, the difference in producer prices between the control villages and the cooperatives was nearly identical to the differences in retail prices. Local marketing margins, which were small, do not appear to have been affected on the average. The differences in prices, however, were small. The difference in producer prices between the two communities was approximately 3 percent.

A comparison of the intercepts in the two nominal retail regressions that represent first-round prices indicates that buffalo milk prices were higher than cow milk prices. This is consistent with the value placed on the higher fat content of buffalo milk. While the differences between the prices of the two commodities varied slightly during the subsequent rounds, the average price of buffalo milk remained greater than that of cow milk. A similar result is indicated by the variable for the share of buffalo milk in the equation for producer prices. Because this variable is the ratio in production, however, it is only a proxy for the percentage of buffalo milk in sales. For producers selling only buffalo milk, the farmgate price received in round 1 would have been Rs 2.33 per kilogram; this was virtually identical to the retail price of buffalo milk. The gap between producer and retail prices varied somewhat over the survey.

The gap was never large, however; it was in the neighborhood of 10 percent of the average price at its largest. It is likely

---

[35] The retail prices are average prices per kilogram in each village in each round, whereas the regressions on producer prices were run on the prices reported by individual farmers.

Table 9—Results of regressions explaining milk prices, January 1983-April 1984

Independent Variable	Nominal			Deflated by Cereal Price Index		
	Retail Price of Buffalo Milk	Retail Price of Cow Milk	Producer Price of Milk	Retail Price of Buffalo Milk	Retail Price of Cow Milk	Producer Price of Milk
	(Rs/kilogram)					
Intercept	2.313	2.103	2.169	2.624	2.386	2.470
Round 2	0.166 (0.032)	0.292 (0.038)	0.069 (0.019)	−0.016 (0.037)	0.132 (0.041)	−0.115 (0.021)
Round 3	0.211 (0.033)	0.345 (0.040)	0.038 (0.021)	−0.254 (0.038)	−0.089 (0.043)	−0.400 (0.023)
Round 4	0.334 (0.032)	0.398 (0.038)	0.130 (0.020)	−0.184 (0.037)	−0.083 (0.041)	−0.365 (0.022)
Round 5	0.267 (0.035)	0.414 (0.041)	0.228 (0.023)	−0.194 (0.040)	−0.017 (0.044)	−0.102 (0.025)
Share of buffalo milk in total production	. . .	. . .	0.151 (0.015)	. . .	. . .	0.150 (0.016)
Control dummy	−0.075 (0.023)	−0.041 (0.027)	−0.067 (0.016)	−0.076 (0.027)	−0.038 (0.029)	−0.074 (0.016)
R^2	0.318	0.352	0.141	0.218	0.118	0.263

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.

Notes: The numbers in parentheses are standard errors.

that many sales in the villages were directly between consumers and producers. This would have eliminated any marketing margin. The study, however, was not designed to document this detail of marketing.

A second set of regressions, which deflate the milk prices by an index of cereal prices, presents a similar picture.[36] The relative price of milk, either retail or farmgate, was lower in the later rounds than in the first. This similarity of the control variable in the two sets of regressions implies that cereal prices did not differ between the communities. This was confirmed by a test of the differences between mean cereal prices.

Marketing Patterns

Utilization of milk production is indicated in Table 10. To no one's surprise, the cooperative communities marketed a higher percentage of their production. This marketing was done almost entirely through the cooperative network. Most of the few sales to other vendors recorded from the cooperative villages occurred in two villages where the cooperatives did not function continuously during the five rounds. Although there is no documentation explaining the sporadic closures in these villages, it appears that a number of producers were able to make alternative marketing arrangements during such closures. Also, a moderate and increasing amount of sales to dairy cooperatives occurred in the control villages. It is possible that the cooperative network extended into some of the control villages between the times the survey was designed and completed.

The difference in the percentage of fluid milk retained for home consumption was

---

[36] The cereal price index is weighted by the average share of various grains in the entire sample and picks up both temporal and spatial variations. It is set to 1 at the mean.

Table 10—Use of milk production, January 1983-April 1984

Round/Type of Village	Sales of Fluid Milk		Home Consumption of Fluid Milk	Milk Converted into:		
	Total Sales	Percent Sold to Cooperative		Ghee	Butter	Yogurt
			(percent of total production)			
Round 1						
Cooperative villages	67.5	67.2	22.4	0.9	1.5	7.6
Control villages	29.3	0.0	46.1	0.7	8.9	14.9
Round 2						
Cooperative villages	56.8	53.8	24.9	1.2	3.9	13.1
Control villages	39.9	0.9	38.6	1.1	6.2	14.2
Round 3						
Cooperative villages	52.7	49.9	27.3	1.0	2.4	16.6
Control villages	27.3	3.3	39.6	1.0	5.3	28.5
Round 4						
Cooperative villages	59.0	56.2	25.7	0.5	1.9	12.9
Control villages	33.1	4.1	37.2	1.4	5.5	22.7
Round 5						
Cooperative villages	58.1	54.9	24.3	0.3	1.3	15.9
Control villages	43.5	19.2	31.5	1.5	3.0	20.4

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.

somewhat offset by higher production in the cooperatives. Nevertheless, average daily household consumption was higher in the control community (655 grams compared to 608). This difference is statistically significant (see the next chapter).

Ghee and butter production was less than 5 percent of total use in all rounds for the villages with cooperatives. The amount of butter and ghee produced was somewhat higher in the control villages, but it remained a small share of total use. Furthermore, data on the use of buttermilk collected during the final round—a low point in butter production—indicated that most buttermilk was consumed by the household or their animals. Both the low production of butter and the absence of a market or exchange channel for buttermilk is in contrast to the pattern of dairy use assumed for more remote regions. The value of butter and ghee sales in the control villages was about 1 percent of the total value of milk output. Similarly, although an appreciable portion of production was turned into yogurt, particularly in the control villages, only a few households reported selling a portion of this production.

A direct study of marketed surplus is largely redundant since marketed surplus is explained by production and consumption, which are discussed in the chapters preceding and following this one. Nevertheless, equation (4) gives the marketing ratio in the community. The regression was estimated using a logit functional form, which bounds the marketing ratios between 0 and 1. In this estimation, the marketing ratio is defined as the value of the sales of fluid milk, butter, or ghee over the total value of production evaluated at fluid milk prices. The logit form is

$$r = \text{ratio} = e^{\beta x}/(1 + e^{\beta x}). \qquad (3)$$

It was estimated by regressing the logarithm of [ratio/(1 − ratio)] for producers only on the set of regressors.[37] The estimation was

---

[37] Strictly speaking, this linearizing transformation cannot be performed when any ratio is either 1 or 0. To simplify, any producer who sold his entire output was assumed to sell 99 percent of his output. Similarly, maximum consumption was set at 99 percent of output.

$$\begin{aligned} r = {} & 1.486 + \underset{(0.011)}{0.132}\,\text{Total Production} \\ & - \underset{(0.0004)}{0.0023}\,\text{Total Production}^2 - \underset{(0.007)}{0.051}\,\text{HHsize} \\ & + \underset{(0.167)}{0.313}\,\text{Cshare} + \underset{(0.066)}{0.266}\,\text{Landless} + \underset{(0.059)}{0.138}\,\text{Marginal} \\ & - \underset{(0.061)}{0.247}\,\text{Large Farm} - \underset{(0.051)}{0.030}\,\text{Dry Season} \\ & - \underset{(0.080)}{0.563}\,\text{Control} + \underset{(0.015)}{0.007}\,\text{Control} \times \text{Production} \\ & - \underset{(0.078)}{0.254}\,\text{Salespris}; \\ R^2 = {} & 0.228; \end{aligned} \tag{4}$$

where $r = \text{Log}[\text{ratio}/(1 - \text{ratio})]$. Salespris is the producer price in the village. The coefficients of this equation are roughly four times the coefficients of a linear proportion model.[38]

The concern here, however, is more with the test of significance than with the actual value of the coefficients. The percentage of production marketed increased with total production, although at a decreasing rate. The marginal effect of total production became negative when daily output exceeded 28 kilograms. Only one household produced this much This production effect accounts for only a small portion of the differences between communities. The negative coefficient of control indicates a significant average difference in the marketed ratio. This difference is approximately 14 percent, using a rule-of-thumb conversion to linear parameters. The lack of significance of the interaction term, Control × Production, implies that there is no evidence that the marginal response to output of control communities and cooperatives differed. Larger households market a smaller proportion. Holding household size constant, households with more children market more, indicating that household demand is lower than for a similarly sized household of adults only. Similarly, the higher ratio of sales for landless and marginal households can be explained by the lower demand of these presumably poorer households. Lower-income households have lower budget shares for luxury goods, but higher shares for grains. With milk production held constant, low-income households are more likely to market milk and purchase grain and other necessities than better-off households.

Finally, the negative effect of higher "salespris" should not be interpreted as the effect of increased profits leading to higher household demand. Although income responses were positive, the effect of a price rise on income was small relative to the coefficient of price in this equation. Here, as elsewhere in the study, the negative price coefficient remains a puzzle.

---

[38] T. Am[illegible]iya, "Qualitative Response Models: A Survey," *Journal of Economic Literature* 19 (December 1981): 1483-1536.

7

DIRECT MEASUREMENT OF THE EFFECT ON CONSUMPTION

This chapter gives estimates of demand curves for milk and other food commodities. Once the parameters of price and income changes are measured, it is fairly straightforward to estimate the effects of observed or anticipated price and income changes; the art of evaluation comes more in delimiting the changes to which the model should be applied. There is, however, a related issue addressed in this chapter. Whereas calculations of income or price effects made while holding demand parameters fixed can be viewed as moving along a demand curve, much of the debate on the effects of dairy cooperatives—and of other ways of intensifying cash cropping—carries implicit assertions that technological change leads to changes in preferences and, therefore, to shifts in demand curves. Evidence for this is presented in the discussion of the demand estimates. Before this discussion, however, it should prove useful to present a brief overview of the descriptive statistics related to food demand in the study area.

Budget Shares and Nutrient Intake in the Sample Sites

Whereas paired comparisons of group means are weak tests of differences between free-living (as opposed to laboratory) populations, the nature of the sample stratification in this study makes the cooperative and the control communities roughly comparable.[39] Table 11, then, gives an indication of the demand patterns to be investigated more formally in the next subsection. There were few apparent differences in the allocation and amount of expenditures between cooperatives and neighboring communities. Indeed, the only budget share for which there was an obvious and consistent difference is for meat. On closer inspection this reflects differences in the number of vegetarians in each group. There also seems to have been a somewhat greater budget share for dairy products in the control villages in all rounds except the second.[40]

There does, however, appear to have been a trend in both communities. While total expenditures apparently declined over the survey period, food expenditures increased. But, relative shares of expenditures on different food commodities did not change appreciably during the survey period.

Table 12 shows that reported calories and proteins consumed were high in all rounds, by Indian standards. But they are consistent with other data for rural Karnataka; the National Institute of Nutrition reports 2,992 calories per consumption unit for a sample in rural Karnataka in 1980.[41] Consumption rose through the survey period. Note, also, that consumption in the survey was stock drawdown plus purchases; physical intakes were not recorded. While calories were calculated using a standard percentage of edible portions for each commodity, wastage and spoilage—particularly from own stocks—were not reported.[42]

---

[39] The sample, more or less, controls for landholding status.

[40] Nonfood expenditures were not recorded in round 1, hence budget shares cannot be calculated. Total food purchases, however, were investigated.

[41] National Institute of Nutrition, "Food and Nutrient Consumption Pattern in the Selected Districts of Different States," Indian Council of Medical Research, Hyderabad, 1981.

[42] The percentages of edible portions were taken from C. Gopalan, Brama Sastri, and S. Balasubramanian, *Nutritive Value of Indian Foods* (Hyderabad: National Institute of Nutrition, 1976).

Table 11—Budget shares allocated to food groups, January 1983-April 1984

Category	Round 2		Round 3		Round 4		Round 5	
	Cooperative Villages	Control Villages	Cooperative Villages	Control Villages	Cooperative Villages	Control Villages	Cooperative Villages	Control Villages
				(percent of budget)				
Grains	35.85	35.49	39.25	40.27	46.84	49.56	48.12	48.18
Dairy	5.67	5.58	4.95	6.06	7.57	8.69	7.63	8.81
Pulses	6.16	6.79	6.18	5.91	6.57	6.83	6.76	6.79
Meat	4.57	3.27	4.60	3.41	4.49	3.35	5.19	3.53
Other foods	16.37	18.42	17.86	16.77	19.48	21.36	20.90	21.33
Total foods	68.62	69.55	72.84	72.42	84.95	89.79	88.60	88.64
Total expenditures per capita (rupees per week)	33.74	29.18	34.57	32.06	31.94	29.65	29.90	30.33
Food expenditures per capita (rupees per week)	23.15	20.29	25.18	23.22	27.13	26.62	26.49	26.88
Average household size	6.68	6.76	6.90	6.56	6.97	6.70	6.86	6.63

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.

Milk and meat, individually and jointly, contributed only a small share to the overall diet.

There was a pattern of increasing calorie consumption with land cultivated per capita, but it was not uniform (Table 13). On the other hand, average calorie intake per expenditure quartile rose regularly with expenditures within each round, with the overall average being 2,216 kilocalories per person per day for the poorest expenditure quartile and 3,237 kilocalories for the highest expenditure quartile. The daily intake was 2,493 for the second quartile and 2,827 for the third. The pattern in consumption according to landholding was weak, reflecting the coarseness of data on land size per

Table 12—Calorie and protein consumption, January 1983-April 1984

Source of Calories or Protein	Round 1		Round 2		Round 3		Round 4		Round 5	
	Cooperative Villages	Control Villages	Cooperative Villages	Control Villages	Cooperative Villages	Control Villages	Cooperative Villages	Control Villages	Cooperative Villages	Control Villages
					(percent of total consumed)					
Calories										
Grains	77.0	77.0	76.0	75.0	78.0	77.0	79.0	79.0	78.0	78.0
Dairy	4.0	4.0	4.0	4.0	4.0	3.0	3.0	3.0	3.0	4.0
Pulses	5.0	4.0	7.0	8.0	7.0	6.0	5.0	6.0	6.0	6.0
Meat	0.7	0.5	0.7	0.4	0.7	0.4	0.6	0.4	0.7	0.4
Total calories	2,479	2,285	2,526	2,372	2,655	2,597	2,806	2,897	2,709	2,773
Protein										
Grains	72.0	75.0	69.0	69.0	70.0	72.0	72.0	73.0	71.0	72.0
Dairy	7.0	7.0	5.0	5.0	4.0	6.0	6.0	7.0	6.0	6.0
Pulses	14.0	12.0	19.0	19.0	16.0	16.0	15.0	14.0	15.0	15.0
Meat	5.0	3.0	4.0	3.0	4.0	3.0	3.0	2.0	4.0	2.0
Total protein (grams)	59	54	62	58	66	64	70	71	66	67

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.

Table 13—Per capita daily energy consumption by quartiles of land cultivated per capita, January 1983-April 1984

Quartile	Round 1	Round 2	Round 3	Round 4	Round 5
			(kilocalories/capita/day)		
1	2,369.76	2,430.01	2,644.04	2,680.81	2,672.25
2	2,330.68	2,388.96	2,483.71	2,817.91	2,735.56
3	2,436.73	2,511.87	2,716.30	2,962.41	2,827.96
4	2,566.24	2,673.71	2,836.07	3,132.67	2,963.85

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.

household and even per capita—uncorrected for irrigation and soil quality—as indicators of access to resources.

However, another factor is at work here as well—consumption patterns and total expenditures varied greatly between rounds for many households. Such a phenomenon is commonly observed in repeated cross-sectional data.[43] In part, this reflects the fluidity of the household; members not only migrated but joined extended families and separated from them between interviews. The variation between periods also reflects, of course, errors of measurement, both random and systematic. Furthermore, the variation reflects obstacles that a household might face when attempting to plan its intertemporal consumption. There may be rationing in the labor and credit markets and an absence of suitable vehicles for saving.

Price movements were only moderate during the study period (Table 14). While the price of rice rose continuously during the year, the prices of maize and ragi remained fairly stable. Gram (chick pea) prices also rose, as did the price of vegetable oil, while meat prices stayed roughly constant in nominal terms. With the exception of the rise between the first and second rounds, retail milk prices also showed only moderate variation. There also appears to have been little difference in the commodity prices between communities. Intraperiod (spatial) price variation was generally below 10 percent of the mean value of each price. This is consistent with, but not proof of, the maintained hypothesis of integrated commodity markets.

Demand Model and Results

The basic model used for estimating the demand parameters is a modified version of the almost ideal demand system (AIDS).[44] The basic model is of the form

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log P_j + \beta_i \log(TX/\pi), \qquad (5)$$

where w_i is the budget share to the i^{th} commodity, P_j denotes the price of the j^{th} good, TX is total expenditures, and π is a price index. The parameters to be estimated are α's, β's, and γ's. In the nonlinear version of AIDS, π is defined internally using the parameters of the system. However, Deaton and Muellbauer have tested the model using an approximation that allows the AIDS to be estimated as a linear model. They found the results not sensitive to this approximation. This analysis uses such an approximation: $\log = \sum w_k \log P_k$. Nonfood prices were not available from the survey questionnaire

---

[43] Christopher Scott, "Practical Problems in Conducting Surveys on Living Standards," in *Conducting Surveys in Developing Countries: Practical Problems and Experience in Brazil, Malaysia and the Philippines,* Living Standards Measurement Study Working Paper 3, ed. Christopher Scott, Paulo de Andre, and Ramesh Chambers (Washington, D.C.: World Bank, 1980).

[44] Angus Deaton and John Muellbauer, "An Almost Ideal Demand System," *American Economic Review* 70 (June 1980): 312-326.

Table 14—Retail prices, by round, January 1983-April 1984

Commodity	Round 1		Round 2		Round 3		Round 4		Round 5	
	Cooperative Villages	Control Villages	Cooperative Villages	Control Villages	Cooperative Villages	Control Villages	Cooperative Villages	Control Villages	Cooperative Villages	Control Villages
	(Rs/kilogram/year)									
Rice	2.98	2.98	3.41	3.40	3.97	4.01	4.11	4.08	4.29	4.12
Maize	1.99	1.94	2.07	2.03	1.92	1.89	1.96	1.96	1.97	1.97
Ragi (eleusine coracora)	1.95	1.95	1.89	1.91	2.01	2.01	2.00	2.00	2.25	2.25
Vegetable oil	14.40	14.40	14.91	14.92	18.09	18.18	16.07	16.06	15.92	16.01
Buffalo milk	2.36	2.21	2.46	2.43	2.52	2.45	2.66	2.56	2.57	2.52
Cow milk	2.09	2.10	2.43	2.32	2.45	2.44	2.50	2.45	2.52	2.49
Goat meat	20.32	20.24	20.02	19.90	19.99	20.03	20.29	20.22	20.51	20.56
Gram	6.64	6.67	6.53	6.52	7.33	7.32	7.65	7.69	7.98	8.00

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.

and were taken from a monthly index of nonfood prices for agricultural laborers in Karnataka.[45] The AIDS has been applied to a combination of time-series and cross-sectional data as it is here, but apparently not in its linearized form nor with household data.[46] Symmetry and homogeneity were imposed by restricting $\gamma_{ij} = \gamma_{ji}$ and $\sum_i \gamma_{ij} = 0$, respectively. While these restrictions were not formally tested, the robustness of policy conclusions based on these estimations was determined by ascertaining whether they hold using an unrestricted model as well.

Furthermore, in the interest of greater flexibility, a quadratic term for expenditure is included.[47] Also, the basic system is modified to include demographic variables such as family size, the proportion of children in the family, and an interaction of family size and total expenditures. The core model, to which later variations are applied in testing the effect of cooperatives, is as follows:

$$
\begin{aligned}
w_i = {} & \alpha_0 + \beta_{1i}\,\mathrm{Lnexp} + \beta_{2i}(\mathrm{Lnexp})^2 + \beta_{3i}\,\mathrm{Nexp} \\
& + \beta_{4i}\,\mathrm{HHsize} + \beta_{5i}\,\mathrm{Cshare} + \beta_{6i}\,\mathrm{Round\ dummy} \\
& + \beta_{7i}\,\mathrm{Vegetarian\ dummy} + \gamma_{1i}\,\mathrm{LnMilkPrice} \\
& + \gamma_{2i}\,\mathrm{LnRicePrice} + \gamma_{3i}\,\mathrm{LnRagiPrice} \\
& + \gamma_{4i}\,\mathrm{LnGramPrice} + \gamma_{5i}\,\mathrm{LnMeatPrice} \\
& + \gamma_{6i}\,\mathrm{LnOtherFoodPrice} \\
& + \gamma_{7i}\,\mathrm{LnNonfoodPrice}, \qquad (6)
\end{aligned}
$$

where

Lnexp = logarithm of total expenditures minus the logarithm of the price index,

Nexp = household size × Lnexp,

HHsize = household size,

Cshare = number of children five years old or under divided by HHsize, and

$\mathrm{Ln}^{(i\mathrm{th})}$price = logarithm of price for each principal commodity.

With the exception of the index on nonfood prices described above, all prices come from the survey data. Prices are consumer prices reported by households, with averages for villages employed when the household did not report a price. The milk price is for fluid milk. When a household produced milk during the week of the interview the price paid to producers for the milk either by the cooperative when they were present or by local vendors was used. This reflects the opportunity cost to the household. Retail prices were used for nonproducers. As the difference between these prices was small, this refinement may be considered more important in principle than in practice. The sample included all observations for which commodity and total expenditures were reported. This excludes round 1.

---

[45] India, Ministry of Agriculture and Irrigation, *Bulletin of Agricultural Statistics*, various issues (New Delhi: Ministry of Agriculture and Irrigation, various years).

[46] Rajan Ray, "The Testing and Estimation of Complete Demand Systems with Household Budget Surveys: An Application of AIDS," *European Economic Review* 17 (1982): 319-369.

[47] Angus Deaton, "Issues in the Methodology of Multimarket Analysis of Agricultural Pricing Policies," Woodrow Wilson School of Development Studies Discussion Papers 116, Princeton University, Princeton, N.J., 1984.

In addition to a set of equations with commodity budget shares as regressors, estimations of equations with calories or protein per capita—for which no budget shares exist—were estimated using the same dependent variables as in equation (6). These are modifications of semilogarithm equations for nutrient demand. While such direct estimations of nutrient demand equations are standard, they have recently received renewed attention under the name of reduced-form nutrient demand equations.[48] They provide a point of comparison to the demand equations specified in terms of expenditures rather than quantities.

Table 15 reports results of the main demand equations while Table 16 presents the expenditure and price elasticities estimated from these results. Variations of this approach that test for institutional effects are discussed below. These variations allow for testing hypotheses of concern to this study and offer improvements over the basic model, but do not appreciably change the price and expenditure parameters from those in Table 16.

There is little need for an extensive discussion of these two tables. The income elasticities are plausible, both relatively and absolutely.[49] The total food expenditure elasticity obtained by weighting the individual commodity elasticities by the corresponding shares of total food expenditures was 0.76. The difference between such an expenditure elasticity and the calorie elasticity reflects the part of the increase in food expenditures that goes toward higher quality (more expensive) foods as income rises rather than toward increasing the quantity of food.[50] A similar observation has recently been reported for South India by Behrman and Deolalikar.[51] But their conclusion that calorie and protein expenditures or income elasticities are negligible is not generalizable; the results shown here indicate an appreciable income response.

The calorie and protein equations measure the net effect of price changes on nutrient consumption. They indicate that only increases in rice and ragi prices significantly reduced nutrient consumption. An increase in milk prices significantly *increases* calorie consumption. This type of substitution has been observed elsewhere as well.[52] From the standpoint of the net effects of changes in food consumption induced by the commercialization of dairying, there appears to be less need for concern over an increase of local milk prices than of local grain prices. The latter could work through reallocations

---

[48] Mark Pitt and Mark Rosenzweig, "Health and Nutrient Consumption Across and Within Farm Households," *Review of Economics and Statistics* 67 (May 1985): 212-223.

[49] See K. Murty, "Consumption and Nutritional Patterns of ICRISAT Mandate Crops in India" (Hyderabad: International Crops Research Institute for the Semi-Arid Tropics, 1983), for other results from India using time-series and cross-sectional data.

[50] The average food and calorie elasticities from low-income strata calculated from various data sets estimated with a functional form similar to the one employed here were 0.82 and 0.48, respectively. See Harold Alderman, "Effects of Price and Income Increases on Food Consumption of Low-Income Consumers," International Food Policy Research Institute, Washington, D.C., 1986.

[51] Jere Behrman and Anil B. Deolalikar, "Will Developing Country Nutrition Improve with Income? A Case Study for Rural South India," *Journal of Political Economy* 95 (June 1987): 492-507.

[52] Mark Pitt, "Food Preferences and Nutrition in Rural Bangladesh," *Review of Economics and Statistics* 65 (February 1983): 105-114. Such a net impact is also discussed in Marcelo Selowsky, "Target Group-Oriented Food Programs: Cost-Effectiveness Comparisons," *American Journal of Agricultural Economics* 61 (1979): 988-994.

Table 15—Coefficients of demand equations, January 1983-April 1984

	Dependent Variable							
Independent Variable	Wmilk (Fluid)	Wrice	Wragi	Wgram	Wmeat	Wother-food	Calories Per Capita	Protein Per Capita
Intercept	−0.1177	−0.5244	1.2785	0.0568	−0.1101	0.1665	−18,426.5461	−341.0153
	(0.0338)	(0.0947)	(0.1125)	(0.0367)	(0.0441)	(0.0720)	(3,869.7770)	(104.5223)
Lnexp	0.0921	0.5086	−0.3208	0.0705	0.0810	0.0876	4,001.3974	95.3343
	(0.0160)	(0.0495)	(0.0546)	(0.0172)	(0.0202)	(0.0354)	(312.8486)	(8.4500)
$(\text{Lnexp})^2$	−0.0135	−0.0700	0.0263	−0.0117	−0.0104	−0.0142	−370.5518	−8.4383
	(0.0022)	(0.0069)	(0.0076)	(0.0024)	(0.0028)	(0.0049)	(43.6578)	(1.1792)
Nexp	−0.0008	−0.0078	0.0012	−0.0004	−0.0010	−0.0002	−71.3469	−1.8861
	(0.0004)	(0.0013)	(0.0015)	(0.0005)	(0.0005)	(0.0009)	(8.3407)	(0.2253)
Household size	0.0016	0.0269	−0.0062	0.0001	0.0033	−0.0018	195.0925	5.1103
	(0.0014)	(0.0044)	(0.0049)	(0.0015)	(0.0018)	(0.0032)	(27.9539)	(0.7550)
Cshare	0.0033	0.000004	−0.0650	0.0088	0.0060	−0.0187	−476.1579	−10.0353
	(0.0047)	(0.0147)	(0.0163)	(0.0051)	(0.0060)	(0.0105)	(92.9509)	(2.5106)
Lnmilk price	−0.0016	−0.0087	0.0068	0.0054	0.0228	−0.0182	157.2246	3.5344
	(0.0054)	(0.0052)	(0.0085)	(0.0048)	(0.0062)	(0.0073)	(106.8712)	(2.8866)
Lnrice price	−0.0087	0.1735	0.0189	−0.0038	0.0105	0.0150	−198.3229	−2.5381
	(0.0052)	(0.0166)	(0.0159)	(0.0059)	(0.0069)	(0.0112)	(117.8576)	(3.1833)
Lnragi price	0.0068	0.0189	0.1413	0.0543	−0.0298	0.0659	−364.1292	−6.3116
	(0.0085)	(0.0159)	(0.0323)	(0.0100)	(0.0120)	(0.0175)	(220.9719)	(5.9684)
Lngram price	0.0054	−0.0038	0.0543	−0.0074	0.0042	0.0173	76.8863	−1.5048
	(0.0048)	(0.0059)	(0.0100)	(0.0093)	(0.0090)	(0.0088)	(214.9159)	(5.8049)
Lnmeat price	0.0228	0.0105	−0.0208	0.0042	0.0384	−0.0162	99.3187	−4.6959
	(0.0062)	(0.0069)	(0.0120)	(0.0090)	(0.0188)	(0.0109)	(307.2035)	(8.2975)
Lnotherfood price	−0.0182	0.0150	0.0659	0.0173	−0.0162	0.0004	656.5056	28.0275
	(0.0073)	(0.0112)	(0.0175)	(0.0088)	(0.0108)	(0.0200)	(280.9725)	(7.5890)
Lnnonfood price	−0.0065	−0.2055	−0.2664	−0.0700	−0.0390	−0.0643	4,523.4367	63.0275
	(0.0145)	(0.0213)	(0.0359)	(0.0180)	(0.0281)	(0.0295)	(1,851.1870)	(7.5890)
Vegetarian dummy	0.0098	0.0085	−0.0397	0.0045	−0.0558	0.0294	−7.9386	−2.5396
	(0.0013)	(0.0039)	(0.0043)	(0.0014)	(0.0016)	(0.0028)	(24.7620)	(0.6688)

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.

Notes: The numbers in parentheses are standard errors. Lnexp is the log of total expenditures minus the log of the price index; Nexp is household size multiplied by Lnexp; Cshare is the number of children divided by household size; and the rest of the Ln variables are logs of prices for principal commodities. W indicates budget share.

Table 16—Income and price elasticities estimated from combined cross-sectional data, January 1983-April 1984

Commodity	Elasticity with Respect to							
	Milk Price	Rice Price	Ragi Price	Gram Price	Meat Price	Otherfood Price	Nonfood Price	Income
Fluid milk	−1.03	−0.17	0.14	0.10	0.46	−0.36	−0.13	0.89
Rice	−0.04	−0.17	0.09	−0.02	0.05	−0.07	−0.98	0.89
Ragi	0.04	0.10	−0.21	0.03	−0.12	0.36	−1.48	0.26
Gram	0.09	−0.06	0.86	−1.17	0.07	0.26	−1.11	0.81
Meat	0.53	0.24	−0.48	0.10	−0.12	−0.38	−0.91	1.08
Other foods	−0.08	0.06	0.29	0.07	−0.07	−1.00	−0.28	0.95
Calories consumed per capita	0.06	−0.08	−0.15	0.03	0.04	0.27	1.88	0.41
Protein consumed per capita	0.06	−0.04	−0.10	−0.02	−0.08	0.47	1.06	0.41

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.

Notes: The data were evaluated using the following representative values:

Income was 30 Rs per capita per week; family size was 7.0. The following mean budget shares were used: milk budget share = 0.05, rice budget share = 0.21, ragi budget share = 0.18, pulse budget share = 0.06, meat budget share = 0.04, other food budget share = 0.23, total food budget share = 0.77. Calories per capita per day were 2,400, and protein per capita per day was 60 grams.

of feed or area. However, a reallocation of area to fodder has yet to occur; little land was devoted to fodder in the sample villages.

The results of the calorie and protein equations do differ somewhat from calculations of price elasticities taken from the commodity demand equations weighted by shares of total calories or protein. These price elasticities derived from the commodity demand equations indicate that total nutrients consumed decreased slightly following an increase in the price of milk.[53] The effect was small (the protein elasticity is −0.04) and may reflect the expression of the demand equations in terms of expenditures and not quantities. Given the range of values, however, the most plausible policy conclusion is that there is no indication that changes in milk prices had a significant effect—either positive or negative—on nutrient consumption through commodity substitution. This is discussed further in the concluding chapter.[54]

The negative or nonsignificant effects of household size on income elasticities do not necessarily represent economies of scale for food purchases. They may indicate instead that real incomes were higher at a given nominal income for larger households because of other economies of scale. The percentage of children showed no significant effect on the budget share equations, although families with more children consumed fewer calories and protein per capita than similarly sized families with fewer children. The equation for milk demand finds no evidence to support the view that milk is mainly used for infants in this community.

The dummy variable for vegetarians indicates higher milk and pulse consumption by these households. This group apparently consumes no fewer calories, although a significant difference in protein consumption was observed. Protein consumption among vegetarians was approximately 4 percent lower than among nonvegetarians.

---

[53] This result is contingent on imposing the restriction of homogeneity and symmetry. The unrestricted equations indicate an increase in calorie or protein consumption following an increase in milk prices. The restrictions on parameters also change the sign of the calorie elasticity with respect to nonfood prices.

[54] A further discussion of price and income response is also presented with the discussion of panel estimates below.

Does the Cooperative Change Consumer Response?

One of the central questions in this study is whether the tendency to consume milk is changed when dairy cooperatives are introduced. In order to test this, a number of variations of the basic fluid milk demand equations are presented in Table 17. Model 1 in that table introduces two new variables, wnich are individually and jointly significant—a dummy variable that is defined as 1 for milk producers and a dummy variable for the existence of a cooperative in the village (defined as 0 if there is a cooperative and 1 if the household is in a control village). Model 2 varies this by replacing the production dummy variable with a continuous variable defined as the value of current milk production as a share of total household expenditure (the price of milk × total production/total expenditures). The interpretation of the alternative production variables is discussed below. At this point, it is sufficient to note that the continuous variable termed milk value gives a better statistical fit and that both models have the same implication regarding the effect of the cooperatives on the consumption of milk.

The dummy variable for residence in the control village was significant ($p<0.005$) in both models. This implies that after controlling for incomes and prices, households in the villages with cooperatives consumed less milk. Using model 2, the dummy variable implies that the average budget share for milk was 9 percent higher in the control villages than in the cooperative villages, given equal incomes and production. Similarly, model 5 indicates that the consumption of butter and ghee was significantly higher in the control villages, with the coefficient of the control dummy variable being 38 percent of the average value of the share of the budget given to butter and ghee in the entire sample. In the same vein, the significant coefficient for control villages in model 6 implies that these villages devoted a greater share of their budgets to yogurt and buttermilk than cooperative villages did, after any price differences in fluid milk are accounted for. The average increase was more than 17 percent of the average budget share in the entire sample.

While a longitudinal study is better suited for a detailed analysis of the manner in which the presence of a cooperative led to a reduction in local milk consumption, some insight can be gained by treating the change as a function of the length of time the cooperative had been established. Intuition suggests that the effects of a cooperative on either tastes or marketing patterns would have been cumulative—that is, increasing with duration and reaching a plateau after some time. A time-series analysis might indicate a logistic or S-shaped curve with a slow initial impact and a subsequent maximum effect. With a cross-section, one would expect that villages that were in the cooperative only a short time would have had smaller shifts in consumption relative to the control than groups that were in the project a longer time. This is tested in model 4. The results do not indicate a clear pattern. Households in cooperatives that were less than two years old did not exhibit a statistically different consumption of fluid milk than households in the control villages, while cooperatives formed two or more years before the survey did show a difference in consumption patterns. The main inconsistency is that cooperatives more than four years old were intermediate between the other two groups of cooperatives rather than representing a trend.

The dummy variables for the presence or age of a cooperative shift the intercept of the demand curve but do not affect the slope. Model 3 presents a variant in which the income response is modified by an interaction between the control dummy variable and the logarithm of expenditures. The model implies that the income elasticity for milk was higher in the control villages by 0.03, or some 3.3 percent of the mean value. The amount is fairly small, although the statistical significance is high ($p<0.001$). Due to collinearity it was not possible to obtain significant results when both an intercept shift and a slope shift were included in the same model. There is no convenient criterion that gives preference for model 3 or model 2 on statistical grounds. However, as they both have the same implication for

Table 17—Variations of basic milk demand equations, January 1983-April 1984

	Dependent Variable							
	Wmilk (Fluid)				Wghee	Wother Dairy	Calories	Protein
Independent Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Intercept	−0.08871 (0.0361)	−0.1167 (0.0347)	−0.1142 (0.0348)	−0.1091 (0.0347)	0.0151 (0.1585)	0.0038 (0.0240)	−18,491.5631 (3,867.3302)	−342.5488 (104.478)
Lnexp	0.0828 (0.0160)	0.0817 (0.0157)	0.0803 (0.0157)	0.0809 (0.0156)	−0.0146 (0.0071)	0.0499 (0.0108)	4,016.7934 (312.7313)	95.6974 (8.4486)
$(\text{Lnexp})^2$	−0.0123 (0.0022)	−0.0122 (0.0022)	−0.0121 (0.0022)	−0.0121 (0.0022)	0.0031 (0.0010)	−0.0060 (0.0015)	−372.0396 (43.6348)	−8.4734 (1.1788)
Nexp	−0.0008 (0.0014)	−0.0006 (0.0004)	−0.0006 (0.0004)	−0.0006 (0.0004)	0.00008 (0.0002)	−0.0007 (0.0003)	−71.1709 (8.3356)	−1.8820 (0.2252)
Household size	0.0016 (0.0014)	0.0011 (0.0014)	0.0011 (0.0014)	0.0010 (0.0014)	0.0003 (0.0006)	0.0028 (0.0009)	194.6850 (27.9361)	5.1007 (0.7547)
CShare	0.0038 (0.0047)	0.0041 (0.0047)	0.0041 (0.0047)	0.0039 (0.0047)	−0.0009 (0.0021)	−0.0036 (0.0032)	−467.1785 (92.9933)	−9.8235 (2.5122)
Lnmilk price	0.0113 (0.0058)	0.0056 (0.0054)	0.0054 (0.0054)	0.0055 (0.0054)	0.0005 (0.0024)	−0.0053 (0.0037)	164.3094 (106.856)	3.7015 (2.8868)
Lnrice price	−0.0128 (0.0057)	−0.0057 (0.0056)	−0.0058 (0.0056)	−0.0058 (0.0056)	−0.0038 (0.0025)	0.0313 (0.0038)	−175.024 (118.332)	−1.9885 (3.1968)
Lnragi price	0.0133 (0.0102)	−0.0086 (0.0098)	−0.0087 (0.0098)	−0.0078 (0.0098)	0.0048 (0.0045)	0.0195 (0.0068)	−374.6438 (220.8848)	−6.5596 (5.9673)
Lngram price	−0.0050 (0.0087)	0.0039 (0.0085)	0.0039 (0.0085)	0.0045 (0.0085)	−0.0043 (0.0039)	0.0635 (0.0059)	76.6289 (214.7727)	−1.5108 (5.8022)
Lnmutton price	0.0300 (0.0151)	0.0249 (0.0149)	0.0249 (0.0149)	0.0254 (0.0149)	0.0015 (0.0068)	−0.0493 (0.0103)	119.1381 (307.1526)	−4.2284 (8.2979)
Lnotherfood price	−0.0364 (0.0099)	−0.0108 (0.0092)	−0.0110 (0.0092)	−0.0116 (0.0092)	0.0097 (0.0042)	−0.0888 (0.0163)	697.9259 (281.5191)	29.0045 (7.6054)
Lnnonfood price	−0.0004 (0.0236)	−0.0093 (0.0232)	−0.0088 (0.0232)	−0.0102 (0.0232)	−0.0084 (0.0106)	0.0298 (0.0161)	4,453.8673 (1,850.2682)	62.2538 (49.9860)
Producer dummy	0.0106 (0.0016)	. . .	. . .	. . .	. . .	. . .	. . .	. . .

(continued)

Table 17—Continued

	Dependent Variable							
	Wmilk (Fluid)				Wghee	Wother Dairy	Calories	Protein
Independent Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Control dummy	0.0038 (0.0013)	0.0051 (0.0013)	. . .	. . .	0.0017 (0.0006)	0.0027 (0.0009)	52.9250 (25.9533)	1.2483 (0.7011)
Control × Lnexp	. . .	. . .	0.0015 (0.0004)	. . .	. . .	. . .	. . .	. . .
Milk value	. . .	0.0227 (0.0020)	0.0227 (0.0020)	0.0228 (0.0020)	0.0071 (0.0009)	0.0197 (0.0014)	. . .	. . .
1-year coop dummy	. . .	. . .	. . .	−0.0025 (0.0016)	. . .	. . .	. . .	. . .
2-4-year coop dummy	. . .	. . .	. . .	−0.0071 (0.0016)	. . .	. . .	. . .	. . .
Over 4-year coop dummy	. . .	. . .	. . .	−0.0049 (0.0016)	. . .	. . .	. . .	. . .
Vegetarian dummy	0.0087 (0.0013)	0.0088 (0.0013)	0.0088 (0.0013)	0.0084 (0.0013)	0.0022 (0.0006)	0.0013 (0.0009)	−18.2038 (25.2524)	−2.7817 (0.6822)

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.

Notes: The numbers in parentheses are standard errors. Lnexp is the log of total expenditures minus the log of the price index; Nexp is household size multiplied by Lnexp; Cshare is the number of children divided by household size; and the rest of the Ln variables are logs of prices for principal commodities. W indicates budget share.

evaluating the effect of cooperatives, this is not a major drawback.

The effect of the cooperatives on milk consumption was tested in terms of the presence or absence of a cooperative in the village rather than in terms of membership. A variant of model 2 that includes an additional dummy variable for membership was explored (but is not reported in Table 17) to test whether actual membership is important. This variable was not significant, although the village dummy variable did not change in size or significance compared to model 2. Although 93 percent of the sample from cooperative villages are members of the cooperatives, there was no indication of multicollinearity. There is some indication, then, that the presence of a cooperative rather than membership influenced the significant difference in milk consumption between the two communities.

This was also indicated by a variant of model 3 (not reported in Table 17) in which the dummy variable for control villages was replaced by two dummy variables—one for households within cooperative villages who produced milk at some time during the year and one for residents who never produced milk. The effect on nonproducers was twice that on producers, after accounting for the reported value of production.

These results lend support to the argument that the presence of a cooperative tends to reduce milk consumption, if income and prices are held constant, either through changes in tastes or through some changes in market structure yet to be specified. However, the net effects on welfare are not clear. Any decrease in the share of milk in the budget must increase the budget share of some other commodities. To measure the net effect on food consumption, dummy variables were included in the demand equations for calories and protein (models 7 and 8 in Table 17). Both models provide evidence that the presence of a cooperative had an effect on the demand for nutrients. Control villages had higher calorie consumption, controlling for income, but the effect is small, about 2 percent of the mean value of consumption. The difference in protein consumption is significant only at the 10 percent level. It also represents 2 percent of mean consumption. The importance of this reduction of nutrient consumption in the context of other price and income changes is discussed further below.

A short digression on substitution may be worthwhile. Although the nutritionist's concern about the effects of a project can be addressed by measuring food intake, other, more general welfare concerns cannot be measured by shifts in budget shares alone. Under the assumption that the prices and incomes of two groups are identical, differences in what they consume are merely indications of different preferences—even if the preferences are induced by a policy or project. However, if the change in budget shares is a consequence of price changes, the direction of the overall effect on welfare can be determined more easily.[55] However, observed prices, including adjustments for marketing margins, are already included in the regressions. These prices refer only to the rupee costs paid or to the rupee costs forgone at the time of a transaction.

It is possible that there is a difference in the other costs that was not seen, or that benefits forgone in the two communities were not observed directly. For example, if search costs or other time allocations necessary to obtain milk differed, then the total resource costs, which the market price underestimates, may also have differed. Furthermore, if these unobserved costs correlate with the presence or absence of a cooperative, then the dummy variable may measure the effect of the costs. Since own-price response is negative, the lower milk consumption in the villages with cooperatives is consistent with a hypothesis that search costs were higher in these villages. This could occur, for example, if there were fewer producers in these villages willing to sell to neighbors rather than selling to the cooperative. The actual market clearing price is the total of cash and noncash transaction costs. The latter were not measured.

---

[55] Utility is nonincreasing (generally decreasing) in the face of a price increase.

Such an unobserved—and, therefore, untestable—effect is likely to affect nonproducers more than producers, as was observed in the data. However, producers within the cooperatives were also observed to have lower milk consumption than producers in the control villages. But here, too, there is the possibility that a price effect went unobserved—the bonus paid to members by cooperatives in proportion to sales. Such rebates would have raised the opportunity cost of milk to members and would be likely to have reduced consumption. As this analysis has used the farmgate price as the appropriate price for producers, the possibility that the price was underestimated must be considered.

To summarize, there is statistically significant evidence that households in villages with cooperatives consumed less milk than households with similar incomes in control villages, whether they were in the cooperative or not. This lower milk consumption, however, did not lead to lower nutrient intakes. The net welfare effect is not known, however, due to the inability to test the hypothesis that the effect was due to changes in tastes rather than differences in the amount of resources required to purchase milk.[56]

The Effect on Production

In the previous subsection, differences in milk consumption were observed between communities, holding production constant. As differences in production were also indicated in Chapter 5, the indirect effects on consumption that may be attributable to changes in production should also be considered. Income effects are one obvious influence on consumption; so are price effects. The net effects of these will be discussed below. In this chapter, however, various shifts in consumption are analyzed separately. There is an interest in testing whether the source of earnings affects consumption patterns.[57] Model 1 in Table 17 includes a dummy variable for milk producers that indicates that producers of milk consume more fluid milk than nonproducers with the same expenditures and facing the same price level. Similarly, models 2-4 indicate that as milk production increases by one unit, consumption increases by 0.023 units.[58] While such an increase may appear intuitive, it should be recalled that the estimating equations already attempted to distinguish between farmgate prices and retail prices, which would control for differences in opportunity costs. Furthermore, any income effect of increased production should already have been recorded as an increase in total expenditures, included as an independent variable in the model. Finally, this effect was observed after controlling for the presence of cooperatives.

Nevertheless, the effect is apparently statistically significant. Although theory usually postulates that production and consumption are optimized separately, this result seems to indicate a link.[59] Furthermore, although the effect is small, it is of the same order of magnitude as the effect on the *budget share* of milk indicated by the dummy variable for control villages. Therefore, the production effect contributes to the net effect of the cooperatives. It is important, then, to investigate whether it is an artifact of the measurement process.

---

[56] George Stigler and Gary Becker, "De Gustibus Non Est Disputandum," *American Economic Review* 67 (March 1977): 76-90, argue that economic factors should be sought before explanations in terms of taste. That is a useful guideline but not, of course, a proof.

[57] Susan Horton, "The Determinants of Nutrient Intakes," *Journal of Development Economics* 19 (September/October 1985): 147-162, and Benton Massell, "Consistent Estimation of Expenditure Elasticities from Cross-Section Data on Households Producing Partly for Subsistence," *Review of Economics and Statistics* 51 (May 1969): 136-142, report such effects but do not explore the issue in depth.

[58] The term "milk value" is calculated as the value of production over total expenditure. The coefficient of this term in the budget equation is the change in quantity consumed over the change in quantity produced, holding total expenditure and prices constant. The complete effects of a production increase, of course, must also include the income effect.

[59] This does not imply that one does not affect the other, but that the production possibility curve and the optimal point on an indifference curve are linked through a plane of prices (including wages). Most household production models are recursive, with consumption being determined by income from the production process as well as by exogenous prices.

Suppose that the coefficient of milk value does not measure how milk consumption is affected by a change of production per se, but by a missing variable. Often higher consumption of agricultural products by producers is attributed to differences in farmgate and market prices, and by costs in time allocated to marketing. For example, suppose that there exists a proportional markup (or discount) over the prices recorded in the data that is attributable to marketing costs. The model employed here, then, is a variant of

$$w_h = \alpha + \beta \ln (P_h \lambda_h), \qquad (7)$$

where λ_h is the proportional price adjustment. The subscript h indicates that the markup or discount differs between households. For a nonproducer, the markup or discount could be 1—that is, no specific adjustment. The approach is general and, as indicated below, the actual value of λ does not affect the results. Equation (7) then can be formulated as

$$w_h = (\bar{\alpha} + \beta \ln \lambda_h) + \beta \ln P_h$$

or

$$w_h = \alpha_h + \beta \ln P_h, \qquad (8)$$

while the estimates in Table 17 use an average intercept term; they are of the form $w_h = \bar{\alpha} + \beta \ln P_h$. A dummy variable for producers will, of course, allow the intercept term to vary according to the category of production. It will not, however, distinguish whether the effect is from unaccounted marketing costs or is a real effect of production. Suppose, however, that a separate intercept can be employed for each household. In such a case, any household-specific value of λ will be recorded in the intercept and will not be proxied by a production variable. The panel nature of the data allows such an approach.[60]

For each household, the average value of all variables for all rounds was calculated and regressions were estimated using the households' deviation in period t from its average. The estimation was performed on the model

$$(w_{ht} - \bar{w}_h) = \beta(X_{ht} - \bar{X}_h), \qquad (9)$$

where X stands for the regressors in equation (6). For the logarithmic variables, the average of the logarithm—not the logarithm of the average—is used. Note that no intercept term is included; the model, in effect, already has an implicit intercept for each household. Variables that do not change over the panel period, such as the dummy variable for the presence of a cooperative, net out in such an approach; that is: $(\text{fixed variable})_{ht} - (\overline{\text{fixed variable}})_h = 0$. Therefore, their effect cannot be studied.

Denoting the variables in this within-sample model as Dwmilk, DLexp, and so forth, the results of such a model are[61]

$$\begin{aligned} \text{Dwmilk} = {} & \underset{(0.0018)}{-0.0201\text{DLexp}} - \underset{(0.0004)}{0.0013\text{DHHsize}} \\ & + \underset{(0.0052)}{0.0064\text{DLmilkp}} - \underset{(0.0056)}{0.0100\text{DLricep}} \\ & - \underset{(0.0086)}{0.0068\text{DLragip}} + \underset{(0.0090)}{0.0072\text{DLgramp}} \\ & + \underset{(0.0147)}{0.0247\text{DLmeatp}} - \underset{(0.0080)}{0.0064\text{DLotherfood}} \\ & - \underset{(0.0433)}{0.0247\text{DLnonfood}} + \underset{(0.0035)}{0.0469\text{Dmvalue}}; \\ R^2 = {} & 0.116. \end{aligned} \qquad (10)$$

Such within-sample models frequently have less variation than cross-sectional models. For example, the change in household expenditures over a short period is generally far less than differences in expenditures observed among a population. For this reason, panel models risk having a low signal to noise ratio. Nevertheless, this particular regression is instructive. The estimated price elasticity is −0.87 and the income elasticity is 0.60; both are slightly lower in absolute value than the parameters in Table 16. However, given the nature of panel data, the differences are not disturbing. The rice and meat cross-price elasticities in this regression are −0.20 and 0.49, respectively. These are nearly identical to the corresponding terms in the combined cross-section and time-series approach.

---

[60] Orly Ashenfelter, Angus Deaton, and Gary Solon, "Does It Make Sense to Collect Panel Data for Developing Countries?" Woodrow Wilson School Development Studies Paper 119 (Princeton University, Princeton, N.J., May 1985), discuss the uses and pitfalls of such data. Zvi Griliches and Jerry Hausman, "Errors in Variables in Panel Data," National Bureau of Economic Research Technical Working Paper 39, Cambridge, Mass., May 1984, discuss the econometric properties of a subset of such models.

[61] The reader should not confuse such notation with a first difference variant of panel models. While they are used in similar circumstances, the econometric properties differ (see Griliches and Hausman, "Errors in Variables in Panel Data").

Before continuing the discussion of the effect of milk production, observe Table 18, which presents demand parameters derived from panel data in a format similar to Table 16.[62] While such a fixed effects approach does not fulfill all the goals of the demand estimates in this section—the effects of the cooperatives cannot be studied—it provides some perspective on the earlier estimates. For example, while it is occasionally argued that high calorie and protein elasticities are more likely artifacts of differences in household effects such as schooling, these effects are controlled in the panel approach with no appreciable differences in elasticities.[63] Not only do the individual commodity expenditure elasticities change only slightly with the panel approach, but so do the calorie and protein elasticities. This is in contrast to Behrman and Deolalikar's results for other villages in South India. At the very least the contrast implies that Behrman and Deolalikar's results are not generalizable. The main difference probably stems from the instrumental variable approach to expenditures that Behrman and Deolalikar use with instruments that vary little in the panel approach and, hence, carry little information. This study uses expenditures as directly observed.

The price parameters from the panel approach can also be interpreted as short-run responses to price changes, whereas the combined cross-sectional data may be considered a more long-term response.[64] The results in Tables 16 and 18 do not differ appreciably, indicating that the price parameters are robust with respect to the handling of fixed household effects.

The particular motivation for this approach, however, is to estimate the coefficient of the deviation of milk production from the household average. This term is close to the value of the corresponding terms in Table 17 and is clearly statistically significant.

One may vary the assumption of a proportional price markup and assume, instead, a fixed marketing markup. The true price would be $\bar{P}_t + \lambda_h$, and a variant of equation (8) that is linear in prices would be more appropriate. The corresponding estimated equation is

$$
\begin{aligned}
\text{Dwmilk} = {} & \underset{(0.00004)}{0.0005\text{Dexpcapita}} - \underset{(0.0004)}{0.0011\text{DHHsize}} \\
& + \underset{(0.0025)}{0.0088\text{Dmilkp}} - \underset{(0.0013)}{0.0021\text{Dricep}} \\
& - \underset{(0.0040)}{0.0013\text{Dragip}} - \underset{(0.0013)}{0.0007\text{Dgramp}} \\
& + \underset{(0.0007)}{0.0010\text{Dmeatp}} - \underset{(0.0008)}{0.0006\text{Dotherfoodp}} \\
& - \underset{(0.0040)}{0.0019\text{Dnonfoodp}} + \underset{(0.0035)}{0.0464\text{Dmvalue}}; \\
R^2 = {} & 0.131. \qquad (11)
\end{aligned}
$$

As expected, this variant has results comparable to the previous model. As both approaches give similar coefficients for

---

[62] These equations do not use the variable Dmvalue. Also, the complete system imposes both symmetry and homogeneity. Only the latter can be imposed in the single equation estimation of equation (10). Hence, some differences in the milk demand parameters are observed.

[63] Jere Behrman and Barbara Wolfe, "More Evidence on Nutritional Demand-Income Seems Overrated and Women's Schooling Underplayed," *Journal of Development Economics* 14 (1984): 105-128; and Behrman and Deolalikar, "Will Developing Country Nutrition Improve with Income?"

[64] C. Peter Timmer and Harold Alderman, "Estimating Consumption Parameters for Food Policy Analysis," *American Journal of Agricultural Economics* 61 (December 1979): 982-987.

Table 18—Income and price elasticities estimated from panel estimates, January 1983-April 1984

	Elasticity with Respect to							
Commodity	Milk Price	Rice Price	Ragi Price	Gram Price	Meat Price	Otherfood Price	Nonfood Price	Income
Fluid milk	−0.99	−0.21	0.09	0.08	0.52	−0.19	−0.30	0.53
Rice	−0.05	−0.19	0.17	−0.06	0.02	0.09	−0.98	0.69
Ragi	0.03	0.19	−0.49	0.10	−0.23	−0.01	−0.57	0.30
Gram	0.07	−0.22	0.29	−0.85	0.42	0.52	−1.23	0.84
Meat	0.65	0.12	−1.05	0.63	−0.09	0.39	−0.86	0.80
Other foods	−0.04	0.08	−0.01	0.14	0.07	−0.83	−0.27	0.73
Calories per capita	0.01	0.07	−0.35	0.19	0.16	−0.20	3.99	0.44
Protein per capita	−0.05	0.08	−0.36	0.18	0.18	−0.07	3.91	0.44

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.

Notes. The data were evaluated using the following representative values:

Income was 30 Rs per capita per week; family size was 7.0. The following mean budget shares were used: milk budget share = 0.05, rice budget share = 0.21, ragi budget share = 0.18, pulse budget share = 0.06, meat budget share = 0.04, other food budget share = 0.23, total food budget share = 0.77. Calories per capita per day were 2,400, and protein per capita per day was 60 grams.

changes in the production of milk despite somewhat different assumptions about the measurement of prices, it is difficult to dismiss this statistically significant result as an artifact of unspecified price or marketing costs.[65]

Cross-sectional regressions that include dummy variables for production frequently show a relationship between production and consumption. In the cross-sectional analysis of this data set, separate dummy variables for producers of ragi and rice indicate that consumption of these grains is higher when the household produces them. The coefficient of the dummy variable for ragi producers is more than 20 percent of the mean value of the household budget share and significant at $p<0.0001$, while the rice producer dummy variable is 6 percent of the mean budget share and is significant at $p<0.005$. While a drawdown of household stocks—which is not a factor with perishable milk—makes an analysis similar to equation (9) difficult, the link between production and consumption may be similar. In Chapter 9 an attempt will be made to put these links together in order to evaluate the net effects of the dairy cooperatives.

---

[65] The variable is virtually unchanged when the model is run on a subset of farmers who always produce some quantity of milk. The effect then is apparently not a corner effect observed upon entry into production.

8

CHANGES IN EXPENDITURE AND INCOME DISTRIBUTION

Changes in dairy production and milk marketing are primary goals of dairy development projects and of Operation Flood in particular. But as cooperative dairying has developed in India it has tended to present itself, and hence has been evaluated, as a way to increase the incomes of the poorer segments of rural India. Comparisons of household incomes, then, should be an important component of any study of the effects of dairy development on households. Incomes, however, are hard to measure in rural communities both because measuring the costs of inputs as well as output is complex and because the variability of short-term earnings masks long-run productive potential. Total expenditures are generally presumed to reflect a household's perception of its long-run earnings. They have the further advantage of being easier to measure than income.

To test whether there were differences in the total household expenditures of the two communities in this study, a regression was run that explains expenditures as a function of household assets and demography:

$$\begin{aligned}
\text{L Totexp} = {} & 4.46 + \underset{(0.00005)}{0.0002}\,\text{Agehead} + \underset{(0.002)}{0.095}\,\text{HHsize} \\
& - \underset{(0.059)}{0.430}\,\text{Cshare} + \underset{(0.016)}{0.122}\,\text{Literacy} \\
& + \underset{(0.024)}{0.089}\,\text{Matriculate} - \underset{(0.027)}{0.232}\,\text{Landless} \\
& - \underset{(0.024)}{0.122}\,\text{Marginal} + \underset{(0.026)}{0.166}\,\text{Largefarm} \\
& + \underset{(0.017)}{0.060}\,\text{Well} - \underset{(0.016)}{0.007}\,\text{Dryseason} \\
& - \underset{(0.034)}{0.071}\,(\text{Control} \times \text{Landless}) \\
& - \underset{(0.028)}{0.032}\,(\text{Control} \times \text{Marginal}) \\
& - \underset{(0.033)}{0.158}\,(\text{Control} \times \text{Mediumfarm}) \\
& - \underset{(0.035)}{0.115}\,(\text{Control} \times \text{Largefarm}); \\
R^2 = {} & 0.59. \qquad (12)
\end{aligned}$$

The regression with the logarithm of daily household expenditures as the dependent variable contains no particular surprises. Households with an older head had higher expenditures than other households with similar assets. Literacy increased household expenditures, with higher education having an additional impact. Larger households had higher total expenditures, controlling for the proportion of children. A separate regression (not shown) indicates that expenditures per capita, however, decreased with household size. Total expenditures increased over landholding groups in correlation with ownership of that asset. Ownership of a well also enhanced household expenditures.

The particular concern here is for the four interaction variables that are the products of the control dummy variable and the landholding class dummy variables. The coefficients measure the proportional difference between the expenditures of a household in one of the various land ownership groups within the control community and a household in the corresponding group in the villages with cooperatives. The signs of all four coefficients are negative, indicating that the control groups had lower expenditures than their neighbors. Presumably they had lower earnings, as there is no indication that savings differed. This, of course, implies that households in cooperative villages had higher expenditures. Marginal farmers appear to have benefited least of the farm groups. The expenditures of the control and project groups in the marginal farm category are not significantly different. Landless farmers in project villages did spend more than those in control villages, but this difference is smaller than the differences seen among medium and large farmers.

Before discussing this further, it is worthwhile to consider the relationship of dairy and nondairy earnings. Earlier it was argued that the project did not affect other crops or labor allocation. If so, although the villages differed in dairy earnings, they should not differ in other earnings. As the data did not directly record farm or off-farm income, an indirect approach would be to subtract dairy earnings—including the value of production consumed at home—from total expenditures and presume that the remainder indicates other earnings.

It should be noted that nondairy earnings far exceeded dairy earnings even within the sample taken from villages with cooperatives. Table 19 indicates that dairy earnings were sufficient to pay for 10-25 percent of total expenditures observed.

A regression for the logarithm of other earnings similar to equation (12) is as follows:

$$\begin{aligned}
\text{Lotherearnings} = {} & 4.14 + \underset{(0.00007)}{0.0002}\ \text{Agehead} \\
& + \underset{(0.003)}{0.102}\ \text{HHsize} - \underset{(0.082)}{0.392}\ \text{Cshare} \\
& + \underset{(0.023)}{0.101}\ \text{Literacy} + \underset{(0.034)}{0.049}\ \text{Matriculate} \\
& - \underset{(0.037)}{0.151}\ \text{Landless} - \underset{(0.016)}{0.016}\ \text{Marginal} \\
& + \underset{(0.037)}{0.178}\ \text{Largefarm} + \underset{(0.025)}{0.021}\ \text{Well} \\
& + \underset{(0.022)}{0.003}\ \text{Dryseason} \\
& + \underset{(0.048)}{0.009}\ (\text{Control} \times \text{Landless}) \\
& + \underset{(0.040)}{0.020}\ (\text{Control} \times \text{Marginal}) \\
& - \underset{(0.047)}{0.029}\ (\text{Control} \times \text{Mediumfarm}) \\
& - \underset{(0.049)}{0.077}\ (\text{Control} \times \text{Largefarm}); \\
R^2 = 0.40. & \qquad (13)
\end{aligned}$$

Table 19—Ratio of the value of milk production to total expenditures, by landholding class, January 1983-April 1984

Landholding Class	Cooperative Villages	Control Villages
Landless	0.164	0.107
Marginal farm households	0.160	0.120
Small farm households	0.218	0.125
Other farm households	0.228	0.191

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.

The major difference between equations (12) and (13) is that the interaction variables do not indicate differences between the control and project communities; none of the coefficients is significant. A second observation is that the relationship of other earnings to landholding size was only moderate. The average value of the dependent variable is 4.96, while the landless group differed from the medium-sized farm class by −0.15 and from the largest landholders by −0.33.

Another way to look at this latter point is to look at the Gini coefficients of expenditures—a measure of distribution in which 1 indicates total concentration of resources and 0 indicates equitable distribution. Gini coefficients for total expenditures per capita are 0.1921 for the project villages and 0.1951 for the control community.[66] While these appear low, it should be recalled that such coefficients are generally lower in a fairly homogeneous rural community than in a larger community with greater divergence in ecological conditions or a higher degree of urbanization. These coefficients are also lower than those for assets—for example, the Gini coefficient for land cultivated was

---

[66] The values are 0.2143 and 0.2050, respectively, if dairy earnings are excluded.

0.5876 in this sample. Although the statistical significance of this measure cannot be ascertained, in both communities dairy earnings lowered the Gini coefficient. A greater drop was observed in the subsector with larger dairy earnings.

Within both the control and project communities, expenditures increased with landholding. This pattern, of course, existed before the project. The project, however, apparently widened this gap since the project appears to have increased dairy earnings more for the larger landholdings than it did for the smaller landholding groups. In no case, however, is there evidence that any particular group of farmers lost absolutely following the introduction of the cooperatives.

9

CONCLUSIONS

A framework for investigating the linkages between agricultural projects and nutrition was presented in Chapter 4. This chapter returns to those hypotheses in order to summarize the results of the study.

Effects on Production

The first hypothesis, that *the project increased milk production,* may be accepted.[67] Average production was twice as high in villages with dairy cooperatives. However, the hypothesis that the project leads to an *increase in production per cow through a shift in production curves* has to be rejected because the increase was achieved primarily through a shift in herd composition. The hypothesis that the increase came about through *a change in input use* may be partially accepted, though the effect of this change is small.

Using the production elasticities from Table 6 and the effects of the cooperative on input use from Table 7, one can calculate that milk production of local cows was 4 percent higher and that of buffalo, 1 percent higher in the villages with cooperatives. No statistically significant differences for input use with crossbred cows were observed.

The project did increase the size of the average herd. This hypothesis may be accepted because the households within cooperatives had 0.39 more milch animals. That it also *resulted in greater investment in improved cattle* may also be accepted. There was an increase of 0.45 crossbred cows and 0.21 buffalo per household in project villages and a decrease of 0.26 local cows.

The hypothesis that *the project did not result in a reduction of income from other activities* is supported by the evidence presented. No significant effects on other income, either positive or negative, were observed to be related to the presence of a cooperative. As virtually no additional fodder was planted in any of the villages, reallocation of land to forage crops is not an issue in this region. Cropping patterns do not appear to have been directly affected; nor were differences in input or output prices observed. However, considering that no measurable effect was discerned, this hypothesis can only be supported, not accepted.

The study also found no negative effects on income distribution, although the positive relationship between dairy earnings and farm holdings makes this finding worth further investigation.

The hypotheses that *the project increased labor earnings through a change in wages or through changes in labor patterns* may both be rejected. No significant differences in reported wages were observed. This also provides support for the hypothesis that the project did not result in a reduction of income from other activities because wages are a major input in agricultural production. Nor were major changes in the amount of labor hired for dairy activity observed. Changes in farm labor could be deduced from the increase in herd size, although this was mitigated by scale economies, as indicated in Table 6. No differences in labor per animal were observed. The net effect, including the effect of herd size and composition, was a 6 percent increase in labor applied to dairy activities. This is a negligible effect on total household labor.

---

[67] For convenience, the hypotheses from Chapter 4 are indicated by italics. When a hypothesis is presented in terms of a measurable effect, "acceptance" implies a difference significant at the 5 percent level. When a hypothesis is worded in terms of the absence of an effect, the failure to measure an effect is indicated by the word "supported." This distinction is meant to distinguish those cases in which a level of significance for acceptance can be stated from those cases in which the conventional tests of significance can reject a hypothesis but not formally accept the alternative of no response.

Effects on Availability of Food Supplies

The study supports the hypothesis that *the project decreased or did not influence the cost of grains.* No statistically significant differences in cereal prices—the main component of food budgets—were reported between project and nonproject sites.

But the hypothesis that *the project had no impact on the retail price of milk* is rejected. Buffalo milk was 3 percent higher in the coöperative villages—a statistically significant amount. A smaller, less significant, difference was also observed for cow milk.

The hypothesis that *no market coercion was observed* was not tested. Households appeared free to change the amount they sold absolutely or relative to production, but no tests of extramarket coercion or obstacles to sales were devised.

Effects on the Desire to Purchase Nutrients

In regard to this last set of hypotheses, the premises that *the project did not influence average propensities to consume either calories or protein* have to be rejected. Small but significant differences in average levels of protein or calorie consumption at a given income level were observed. These were measured as a neutral shift of calorie or protein demand rather than as an increase in the marginal propensity to consume.

Similarly, the hypothesis that *the project had no influence on the average propensity to consume milk* may also be rejected. That is, with income and price held constant, people in the project areas consumed less milk. This could be either a neutral reduction over all income levels or a less steep relationship of income and milk consumption than in other areas.

To determine what portion of the total effect of change in nutrient demand may be attributed to the introduction of dairy cooperatives, it is necessary to add the effects of changes in income, prices, production, and the presence of cooperatives. Inasmuch as the data do not show that wages, employment, or the prices or allocation of land to cereal crops changed, differences in total expenditures between the two communities may be attributed to the dairy project. As stated earlier, the limited increase in the number of animals may account for the lack of increase in herd labor.

When calculated in a manner similar to equation (12), the average difference in expenditures was 8 percent. Similarly, equation (3) from Table 9 indicates that milk prices differed by 3 percent. These changes, along with the appropriate elasticities from Table 18, give the effects reported in Table 20. Similarly, the effect that can be attributed to the cooperative was calculated using the coefficients of the control dummy variable from models 2, 7, and 8 in Table 17, converted to percentage terms. The producer effect was calculated using the coefficient of milk value from equation (10), assuming a 5 percent increase in the appropriate ratio of the value of milk production to total expenditures. The producer effect used to calculate changes in calories or proteins came from estimates not included in the text. These terms were not significant and are included mainly for comparison with the calculations for milk.

Nonproducers in the villages with cooperatives had a net decrease in their milk and nutrient consumption. Since these effects were calculated using short-run changes in expenditures or milk production, this presumably also pertained to producers when their cows were not lactating. Milk producers had a net decrease in milk consumption, but a net increase in nutrient consumption. This was due to the positive income effect that overrode the negative effect of the cooperatives on consumption. This is important. The potential of the project to improve nutrition had nothing to do with changes in milk consumption per se, nor with changes in milk prices, but with the potential for

Table 20—Changes in milk, calorie, and protein consumption attributed to dairy cooperatives in Karnataka, January 1983-April 1984

Type of Consumption/ Source of Change	Producers	Nonproducers
	(percent)	
Fluid milk consumption		
Due to price change	−3.0	−3.0
Due to increased income	3.5	. . .
Producer effect	7.0	. . .
Cooperative effect	−9.0	−9.0
Net change	−1.5	−12.1
Energy consumption		
Due to price change	0.0	0.0
Due to income change	3.8	. . .
Producer effect	0.0	−2.1
Cooperative effect	−2.1	−2.1
Net change	1.7	−2.1
Consumption		
Due to price change	−0.1	−0.1
Due to income change	3.8	. . .
Producer effect	0.3	. . .
Cooperative effect	−1.9	−1.9
Net change	2.1	−2.0

Source: Data from the household survey conducted in Karnataka by the International Food Policy Research Institute and the Centre for Rural Development Studies, University of Bangalore, January 1983-April 1984.

Notes: The producer effect is the impact of milk production on demand, and the cooperative effect is the impact of the presence of a cooperative on demand, with income and price held constant in both instances.

increasing income. Policies that attempt to increase milk consumption may moderate increases in income and so are counterproductive to reaching nutritional goals. In this calculation, the cooperative affected producers and nonproducers equally. No further negative effects are likely if production in the villages is increased.

Note also that the price effects shown here were calculated using the panel approach. If the combined time-series and cross-sectional data are used, the effect of an increase in milk prices on nutrient consumption is a small increase. The net result is that there is no measurable decline in nutrient consumption even for nonproducers. Since the decline ranges between negligible and small, there seems to be little rationale for designing dairy policy in this region around its possible effect on the nutrition of consumers.

10

POLICY IMPLICATIONS

The current study is one of the most extensive empirical investigations of dairy development in India. While no single study can provide insight relevant to all the diverse conditions of India, the evidence presented can provide some guidelines for future policy and for future research.

The dairy cooperatives appear to be slowly transforming the nature of dairy production in the project sites. The indigenous cow is being replaced by both crossbred cows and by buffalo. However, the adoption of crossbred cows has not accelerated with the length of membership in the cooperative. This poses a challenge to planners. More than half the crossbred cattle in the sample were obtained by purchases rather than through farm breeding, even in the older cooperatives. Although this study does not have enough data on private or public investment to undertake a benefit-cost analysis, it should be clear that the social returns to a project will be far lower if investment in capital comes from disinvestment elsewhere than if the project encourages a net increase in breeding of crossbred cattle.

Given that many farmers obtain their crossbred cattle from purchases, thereby avoiding both the risk of getting an unwanted crossbred male and the difficulty of breeding and feeding a crossbred calf with the volume of milk produced by a local variety cow, the possibility that the dairy development corporation might provide calves bred centrally rather than by artificial insemination in the villages might be explored. Similarly, the conclusion that farmers in Karnataka, like those in other regions in India, still maintain more buffalo than cows for milk implies an obvious orientation for animal breeders. Perhaps improvement of buffalo can take precedence over or at least equal priority with the strategy of promoting crossbred cattle. Given that the proportion of buffalo to other animals is higher among the landless, upgrading buffalo may further the equity goals of the project. While the National Dairy Development Board has taken some steps along these lines, it is not clear that such a promotion should be accomplished through the cooperatives rather than through other agricultural programs.

The difference in crossbred stocking rates raises another issue for further consideration. If crossbred cattle are more profitable than other animals, what prevents farmers in the control villages from adopting the technology? Considering the role of education in the adoption of crossbred cattle, it is possible that the cooperative provides a similar effect as a conduit for information necessary for successful adoption. If the cooperative reduces risk or raises profitability, why is this not reflected strongly in other aspects of dairy investment and production? On the other hand, if the difference reflects a subsidy to cooperatives or rationing of scarce capital made possible by a near monopoly on exotic breeding stock, then the production benefits apparent in the cooperatives have little to do with the cooperative structure per se.

While many forms of agricultural insurance are not viable due to difficulties in monitoring damage, guaranteeing incentives to maintain property or apply inputs, and the high covariance of risk over a small area,[68] smoothly functioning cooperatives could reduce these obstacles and provide insurance themselves for owners of crossbred cattle and improved buffalo. Village cooperatives would be better able to estimate their level of effort and risk than more distant insurers. At the same time, cooperatives could pool with a larger union to share risks. The temptation to subsidize such a scheme is great, however, and were that to occur, there would be the additional risk that the insurance would be provided only to the wealthier, more powerful farmers. The usefulness of such an approach in encouraging adoption of new breeds of cows and buffalos, then, depends on the degree to which the cooperatives are truly cooperative in structure.

---

[68] Peter B. R. Hazell, Carlos Pomareda, and Alberto Valdés, *Crop Insurance for Agricultural Development: Issues and Experience* (Baltimore, Md.: Johns Hopkins University Press, 1986). See also, Hans Binswanger and Mark Rosenzweig, "Behavioral and Material Determinants for Production Relations in Agriculture," *Journal of Development Studies* 22 (April 1986): 503-539.

If, as the data from the sample surveyed here imply, there were no major differences in inputs per animal type or of changes in fodder production, the project must be considered a failure in this respect. The effect on local practices is more gradual than dramatic. According to these data, too little concentrate and green fodder have been supplied to maintain weight during lactation and still yield milk near an animal's genetic potential under field conditions. This has been observed elsewhere in Karnataka as well.[69] Until the use of concentrates increases, the full potential of crossbred cattle is unlikely to be fulfilled. Here, as with investment in crossbred animals, the difference between farmers' choices and those of the planners must be taken as a signal. Technological packages are often adopted piecemeal; that must be understood when investments and projections are made. Moreover, when a portion of a package is not universally adopted, one must consider whether what is being offered is unsuited to local economic or physical conditions or both.

The current study was unable to ascertain either how profitable dairying was in the region, or the optimal amount of feed inputs. Nevertheless, a few remarks about pricing are warranted. First, the price advantage enjoyed by producers in cooperatives was small relative to other local villages; the measured difference in milk prices averaged 3 percent, controlling for animal type. While it may be that the presence of cooperatives kept private vendors from taking larger profits, the converse is also possible. In any case, no evidence warranting elimination or increased regulation of these traders was found in the study.

During the period of the survey, milk prices fell relative to grain prices. Dairy prices are largely determined by the prices in the urban market, plus marketing costs. If urban prices are rigid, particularly if they are depressed by local regulations, there is an obvious potential for thwarting development goals for the dairy sector.

According to the results of this survey, there is no nutritional justification for controlling the price of milk. Although the own-price elasticities of dairy goods are large, so are the cross-price elasticities. The net effect on nutrient consumption of an increase in dairy prices was virtually zero, except with regard to the effect on producer incomes. Nonproducers of milk may decrease their dairy consumption following such a price increase, but such a decrease is from a small base. Furthermore, because only a small share of nonproducers' budgets is given to milk, the effect of a price increase on their real income is still small. A greater concern from the standpoint of nutrition is the relationship of ragi prices to nutrient consumption. Caution must be taken to ensure that the demand for feed does not put upward pressure on the prices of coarse grains in the region.

Furthermore, marketing patterns—production minus demand—differ in the cooperative villages, leading to less consumption of milk by milk producers at a given amount produced, compared with milk producers in the control villages. Nevertheless, the effects of increased production work through both income and preferences to offset some of this. In general, the value of dairy development in this region is neither augmented nor reduced by nutritional linkages: instead benefits come through increased income and its distribution. To the degree that such income streams justify the investment, the project is warranted.

---

[69] Sridhara, Munegowda, and Krishnamurthy, *Applied Forage Research.*

BIBLIOGRAPHY

Alderman, Harold. "Effects of Price and Income Increases on Food Consumption of Low-Income Consumers." International Food Policy Research Institute, Washington, D.C., 1986.

Alderman, Harold; Mergos, George; and Slade, Roger. *Cooperative Dairy Development in India: Evolution, Debate, and Evidence.* Working Paper on Commercialization of Agriculture and Nutrition 2. Washington, D.C.: International Food Policy Research Institute, 1987.

Alvares, C. "Operation Flood: The White Lie." *Illustrated Weekly of India* (October 30, 1983), pp. 8-13.

Amemiya, T. "Qualitative Response Models: A Survey." *Journal of Economic Literature* 19 (December 1981): 1483-1536.

Ashenfelter, Orly; Deaton, Angus; and Solon, Gary. "Does It Make Sense to Collect Panel Data for Developing Countries?" Woodrow Wilson School Development Studies Discussion Paper 119. Princeton University, Princeton, N.J., May 1985.

Behrman, Jere, and Deolalikar, Anil B. "Will Developing Country Nutrition Improve with Income? A Case Study for Rural South India." *Journal of Political Economy* 95 (June 1987): 492-507.

Behrman, Jere, and Wolfe, Barbara. "More Evidence on Nutritional Demand-Income Seems Overrated and Women's Schooling Underplayed." *Journal of Development Economics* 14 (1984): 105-128.

Binswanger, Hans, and Rosenzweig, Mark. "Behavioral and Material Determinants for Production Relations in Agriculture," *Journal of Development Studies* 22 (April 1986): 503-539.

Braun, Joachim von, and Kennedy, Eileen. *Commercialization of Subsistence Agriculture: Income and Nutritional Effects in Developing Countries.* Working Papers on Commercialization of Agriculture and Nutrition 1. Washington, D.C.: International Food Policy Research Institute, 1986.

Crotty, Raymond. "Operation Flood and the EEC." *Economic and Political Weekly* (April 1983): 522.

Deaton, Angus. "Issues in the Methodology of Multimarket Analysis of Agricultural Pricing Policies." Woodrow Wilson School Development Studies Discussion Paper 116. Princeton University, Princeton, N.J., July 1984.

______. "Theoretical and Empirical Approaches to Consumer Demand Under Rationing." In *Essays on Theory and Measurement of Consumer Behavior in Honor of Sir Richard Stone.* Edited by Angus Deaton. Cambridge: Cambridge University Press, 1981.

Deaton, Angus, and Muellbauer, John. "An Almost Ideal Demand System." *American Economic Review* 70 (June 1980): 312-316.

George, Shanti. "Cooperatives and Indian Dairy Policy: More Anand than Pattern." In *Cooperatives and Rural Development.* Edited by Donald W. Attwood and B. S. Baviskar. Delhi: Oxford University Press, 1983.

Gopalan, C.; Sastri, Brama; and Balasubramanian, S. *Nutritive Value of Indian Foods.* Hyderabad: National Institute of Nutrition, 1976.

Griliches, Zvi, and Hausman, Jerry. "Errors in Variables in Panel Data." National Bureau of Economic Research Technical Working Paper 39. Cambridge, Mass., May 1984.

Hazell, Peter B. R.; Pomareda, Carlos; and Valdés, Alberto. *Crop Insurance for Agricultural Development: Issues and Experience.* Baltimore, Md.: Johns Hopkins University Press, 1986.

Heckman, James. "Sample Selection Bias as a Specification Error." *Econometrica* 47 (January 1979): 153-162.

Horton, Susan. "The Determinants of Nutrient Intakes." *Journal of Development Economics* 19 (September/October 1985): 147-162.

India, Directorate of Census. *Census of India 1971, District Survey Tables,* various volumes. Bangalore: Directorate of Census, 1973.

India, Ministry of Agriculture and Irrigation. *Bulletin of Agricultural Statistics,* various issues. India: Ministry of Agriculture and Irrigation, various years.

Lipton, Michael. "Indian Agricultural Development and African Food Strategies: A Role for the EEC." In *India and the European Community.* Edited by W. Callewaert. Brussels: Center for European Policy Studies, 1985.

McDowell, R. E. "Crossbreeding in Tropical Areas with Emphasis on Milk, Health and Fitness." *Journal of Dairy Science* 68 (No. 9, 1984): 2418-2435.

Maddala, George. *Limited Dependent and Qualitative Variables in Economics.* Cambridge: Cambridge University Press, 1983.

Massell, Benton. "Consistent Estimation of Expenditure Elasticities from Cross-Section Data on Households Producing Partly for Subsistence." *Review of Economics and Statistics* 51 (May 1969): 136-142.

Mellor, John W. *The New Economics of Growth: A Strategy for India and the Developing World.* Ithaca, N.Y.: Cornell University Press, 1976.

Mergos, George, and Slade, Roger. *Dairy Development and Milk Cooperatives: The Effects of a Dairy Project in India.* World Bank Discussion Paper No. 15. Washington, D.C.: World Bank, 1987.

Murty, K. "Consumption and Nutritional Patterns of ICRISAT Mandate Crops in India." Hyderabad: International Crop Research Institute for Semi-Arid Tropics, 1983.

Nair, K., and Jackson, M. "Alternatives to Operation Flood II Strategy." *Economic and Political Weekly* (December 1981): 2129-2132.

National Dairy Development Board. *Breeding and Feeding for Milk Production in Operation Flood II.* Anand: NDDB, 1980.

______. *Nutritional Impact of Operation Flood.* Anand: NDDB, 1983.

National Institute of Nutrition. "Food and Nutrient Consumption Pattern in the Selected Districts of Different States." Indian Council of Medical Research, Hyderabad, 1981.

Pinstrup-Andersen, Per. "The Impact of Export Crop Production on Human Nutrition." In *Nutrition and Development.* Edited by Margaret Biswas and Per Pinstrup-Andersen. Oxford: Oxford University Press, 1985.

Pitt, Mark. "Food Preferences and Nutrition in Rural Bangladesh." *Review of Economics and Statistics* 65 (February 1983): 105-114.

Pitt, Mark, and Rosenzweig, Mark. "Health and Nutrient Consumption Across and Within Farm Households." *Review of Economics and Statistics* 67 (May 1985): 212-223.

Ray, Rajan. "The Testing and Estimation of Complete Demand Systems with Household Budget Surveys: An Application of AIDS." *European Economic Review* 17 (March 1982): 319-369.

Sarvekshana 8 (July 1984).

Sawart, S. "Investigation of the Hypothesis of Deceleration of Indian Agriculture." *Indian Journal of Agricultural Economics* 38 (1983): 475-491.

Scott, C. "Practical Problems in Conducting Surveys on Living Standards." In *Conducting Surveys in Developing Countries: Practical Problems and Experience in Brazil, Malaysia, and the Philippines,* Living Standards Measurement Study, Working Paper 3. Edited by C. Scott, P. de Andre, and R. Chambers. Washington, D.C.: World Bank, 1980.

Selowsky, Marcelo. "Target Group-Oriented Food Programs: Cost-Effectiveness Comparisons." *American Journal of Agricultural Economics* 61 (1979): 988-994.

Singh, Inderjit; Squire, Lyn; and Strauss, John, eds. *Agricultural Household Models: Extensions, Application, and Policy.* Baltimore, Md.: Johns Hopkins University Press, 1986.

Singh, Katar; Srinivasan, R.; and Raju, K. V. *Project Completion Report: Karnataka Dairy Development Project.* Anand: Institute of Rural Management, 1985.

Singh, Surendar. "Operation Flood II: Some Constraints and Implications." *Economic and Political Weekly* (October 1979): 1765-1774.

Singh, S. P., and Kelley, P. *AMUL: An Experiment in Rural Economic Development.* New Delhi: Macmillan, 1981.

Sridhara, H.; Munegowda, M.; and Krishnamurthy, K. "Part II—Study on the Basic Resources and Potentials of the Dairy Farmer in KDDC Command Area—A Benchmark Survey." *Applied Forage Research and Demonstration in the KDDC Command Area of Karnataka.* Bangalore: University of Agricultural Science, 1983.

______. "Part III—Study on the Impact of KDDC Milk Supply Scheme on the Rural Economy in the KDDC Command Area." *Applied Forage Research and Demonstration in the KDDC Command Area of Karnataka.* Bangalore: University of Agricultural Science, 1984.

Stigler, George, and Becker, Gary. "De Gustibus Non Est Disputandum." *American Economic Review* 67 (March 1977): 76-90.

Terhal, Piet, and Doornbos, Martin. "Operation Flood: Development and Commercialization." *Food Policy* 8 (August 1983): 235-239.

Timmer, C. Peter. "A Model of Rice Marketing Margins in Indonesia." *Food Research Institute Studies* 13 (No. 2, 1974): 145-167.

Timmer, C. Peter, and Alderman, Harold. "Estimating Consumption Parameters for Food Policy Analysis." *American Journal of Agricultural Economics* 61 (December 1979): 982-987.

RECENT IFPRI RESEARCH REPORTS (continued)

45 *THE EFFECTS OF THE EGYPTIAN FOOD RATION AND SUBSIDY SYSTEM ON INCOME DISTRIBUTION AND CONSUMPTION,* July 1984, by Harold Alderman and Joachim von Braun

44 *CONSTRAINTS ON KENYA'S FOOD AND BEVERAGE EXPORTS,* April 1984, by Michael Schluter

43 *CLOSING THE CEREALS GAP WITH TRADE AND FOOD AID,* January 1984, by Barbara Huddleston

42 *THE EFFECTS OF FOOD PRICE AND SUBSIDY POLICIES ON EGYPTIAN AGRICULTURE,* November 1983, by Joachim von Braun and Hartwig de Haen

41 *RURAL GROWTH LINKAGES: HOUSEHOLD EXPENDITURE PATTERNS IN MALAYSIA AND NIGERIA,* September 1983, by Peter B. R. Hazell and Ailsa Röell

40 *FOOD SUBSIDIES IN EGYPT: THEIR IMPACT ON FOREIGN EXCHANGE AND TRADE,* August 1983, by Grant M. Scobie

39 *THE WORLD RICE MARKET: STRUCTURE, CONDUCT, AND PERFORMANCE,* June 1983, by Ammar Siamwalla and Stephen Haykin

38 *POLICY MODELING OF A DUAL GRAIN MARKET: THE CASE OF WHEAT IN INDIA,* May 1983, by Raj Krishna and Ajay Chhibber

37 *SERVICE PROVISION AND RURAL DEVELOPMENT IN INDIA: A STUDY OF MIRYALGUDA TALUKA,* February 1983, by Sudhir Wanmali

36 *AGRICULTURE AND ECONOMIC GROWTH IN AN OPEN ECONOMY: THE CASE OF ARGENTINA,* December 1982, by Domingo Cavallo and Yair Mundlak

35 *POLICY OPTIONS FOR THE GRAIN ECONOMY OF THE EUROPEAN COMMUNITY: IMPLICATIONS FOR DEVELOPING COUNTRIES,* November 1982, by Ulrich Koester

34 *EGYPT'S FOOD SUBSIDY AND RATIONING SYSTEM: A DESCRIPTION,* October 1982, by Harold Alderman, Joachim von Braun, and Sakr Ahmed Sakr

33 *AGRICULTURAL GROWTH AND INDUSTRIAL PERFORMANCE IN INDIA,* October 1982, by C. Rangarajan

32 *FOOD CONSUMPTION PARAMETERS FOR BRAZIL AND THEIR APPLICATION TO FOOD POLICY,* September 1982, by Cheryl Williamson Gray

31 *SUSTAINING RAPID GROWTH IN INDIA'S FERTILIZER CONSUMPTION: A PERSPECTIVE BASED ON COMPOSITION OF USE,* August 1982, by Gunvant M. Desai

30 *INSTABILITY IN INDIAN FOODGRAIN PRODUCTION,* May 1982, by Peter B. R. Hazell

29 *GOVERNMENT POLICY AND FOOD IMPORTS: THE CASE OF WHEAT IN EGYPT,* December 1981, by Grant M. Scobie

28 *GROWTH AND EQUITY: POLICIES AND IMPLEMENTATION IN INDIAN AGRICULTURE,* November 1981, by J. S. Sarma

27 *AGRICULTURAL PRICE POLICIES UNDER COMPLEX SOCIOECONOMIC AND NATURAL CONSTRAINTS: THE CASE OF BANGLADESH,* October 1981, by Raisuddin Ahmed

26 *FOOD SECURITY IN THE SAHEL: VARIABLE IMPORT LEVY, GRAIN RESERVES, AND FOREIGN EXCHANGE ASSISTANCE,* September 1981, by John McIntire

25 *INSTABILITY IN INDIAN AGRICULTURE IN THE CONTEXT OF THE NEW TECHNOLOGY,* July 1981, by Shakuntla Mehra

Harold Alderman joined the International Food Policy Research Institute as a research fellow in 1981.

RECENT IFPRI RESEARCH REPORTS

63 *INCOME AND NUTRITIONAL EFFECTS OF THE COMMERCIALIZATION OF AGRICULTURE IN SOUTHWESTERN KENYA,* November 1987, by Eileen T. Kennedy and Bruce Cogill

62 *AGRICULTURAL RESEARCH IN NEPAL: RESOURCE ALLOCATION, STRUCTURE, AND INCENTIVES,* September 1987, by Ram P. Yadav

61 *THE PILOT FOOD PRICE SUBSIDY SCHEME IN THE PHILIPPINES: ITS IMPACT ON INCOME, FOOD CONSUMPTION, AND NUTRITIONAL STATUS,* August 1987, by Marito Garcia and Per Pinstrup-Andersen

60 *POPULATION POLICY AND INDIVIDUAL CHOICE: A THEORETICAL INVESTIGATION,* June 1987, by Marc Nerlove, Assaf Razin, and Efraim Sadka

59 *PRODUCTION INCENTIVES IN PHILIPPINE AGRICULTURE: EFFECTS OF TRADE AND EXCHANGE RATE POLICIES,* May 1987, by Romeo M. Bautista

58 *THE FOOD STAMP SCHEME IN SRI LANKA: COSTS, BENEFITS, AND OPTIONS FOR MODIFICATION,* March 1987, by Neville Edirisinghe

57 *CEREAL FEED USE IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 2000,* December 1986, by J. S. Sarma

56 *THE EFFECTS OF TRADE AND EXCHANGE RATE POLICIES ON AGRICULTURE IN ZAIRE,* November 1986, by Tshikala B. Tshibaka

55 *THE EFFECTS OF TRADE AND EXCHANGE RATE POLICIES ON AGRICULTURE IN NIGERIA,* October 1986, by T. Ademola Oyejide

54 *WEATHER AND GRAIN YIELDS IN THE SOVIET UNION,* September 1986, by Padma Desai

53 *REGIONAL COOPERATION TO IMPROVE FOOD SECURITY IN SOUTHERN AND EASTERN AFRICAN COUNTRIES,* July 1986, by Ulrich Koester

52 *FOOD IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 2000,* June 1986, by Leonardo A. Paulino

51 *DETERMINANTS OF AGRICULTURAL POLICIES IN THE UNITED STATES AND THE EUROPEAN COMMUNITY,* November 1985, by Michel Petit

50 *GOVERNMENT EXPENDITURES ON AGRICULTURE AND AGRICULTURAL GROWTH IN LATIN AMERICA,* October 1985, by Victor J. Elías

49 *LIVESTOCK PRODUCTS IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 1990 AND 2000,* April 1985, by J. S. Sarma and Patrick Yeung

48 *RURAL HOUSEHOLD USE OF SERVICES: A STUDY OF MIRYALGUDA TALUKA, INDIA,* March 1985, by Sudhir Wanmali

47 *EVOLVING FOOD GAPS IN THE MIDDLE EAST/NORTH AFRICA: PROSPECTS AND POLICY IMPLICATIONS,* December 1984, by Nabil Khaldi

46 *THE EFFECTS ON INCOME DISTRIBUTION AND NUTRITION OF ALTERNATIVE RICE PRICE POLICIES IN THAILAND,* November 1984, by Prasarn Trairatvorakul

(continued on inside back cover)

International Food Policy Research Institute
1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 USA

R5620-1.10F(A)
5/88

RESEARCH REPORT

65

CREDIT FOR ALLEVIATION OF RURAL POVERTY: THE GRAMEEN BANK IN BANGLADESH

Mahabub Hossain

February 1988

INTERNATIONAL
FOOD
POLICY
RESEARCH
INSTITUTE

In collaboration with the
BANGLADESH
INSTITUTE OF
DEVELOPMENT
STUDIES

The **International Food Policy Research Institute** was established in 1975 to identify and analyze alternative national and international strategies and policies for meeting food needs in the world, with particular emphasis on low-income countries and on the poorer groups in those countries. While the research effort is geared to the precise objective of contributing to the reduction of hunger and malnutrition, the factors involved are many and wide-ranging, requiring analysis of underlying processes and extending beyond a narrowly defined food sector. The Institute's research program reflects worldwide interaction with policymakers, administrators, and others concerned with increasing food production and with improving the equity of its distribution. Research results are published and distributed to officials and others concerned with national and international food and agricultural policy.

The Institute receives support as a constituent of the Consultative Group on International Agricultural Research from a number of donors including the United States, the World Bank, Japan, Canada, the United Kingdom, the Netherlands, Australia, the Ford Foundation, Italy, Norway, the Federal Republic of Germany, India, the Philippines, Switzerland, Belgium, and the People's Republic of China. In addition, a number of other governments and institutions contribute funding to special research projects.

Board of Trustees

Dick de Zeeuw
Chairman, Netherlands

Ralph Kirby Davidson
Vice Chairman, U.S.A.

Eliseu Roberto de Andrade Alves
Brazil

Yahia Bakour
Syria

Ivan L. Head
Canada

Dharma Kumar
India

Anne de Lattre
France

James R. McWilliam
Australia

Philip Ndegwa
Kenya

Saburo Okita
Japan

Sukadji Ranuwihardjo
Indonesia

Theodore W. Schultz
U.S.A.

Leopoldo Solis
Mexico

M. Syeduzzaman
Bangladesh

Charles Valy Tuho
Côte d'Ivoire

John W. Mellor, Director
Ex Officio, U.S.A.

CREDIT FOR ALLEVIATION OF RURAL POVERTY: THE GRAMEEN BANK IN BANGLADESH

Mahabub Hossain

Research Report 65
International Food Policy Research Institute
in collaboration with the
Bangladesh Institute of Development Studies
February 1988

Copyright 1988 International Food Policy Research Institute.

All rights reserved. Sections of this report may be reproduced without the express permission of but with acknowledgment to the International Food Policy Research Institute.

Library of Congress Cataloging
in Publication Data

Hossain, Mahabub, 1945-
Credit for alleviation of rural poverty.

(Research report ; 65)
Bibliography: p. 85.
1. Grameen Bank. 2. Rural poor—Bangladesh. 3. Small business—Bangladesh. I. Title. II. Series: Research report (International Food Policy Research Institute) ; 65.

HG3290.6.A8G735 1988 332.1'753'095492
88-599 ISBN 0-89629-067-0

CONTENTS

Foreword

1. Summary 9

2. Introduction 12

3. Socioeconomic Environment and the Role of Credit 15

4. Organization and Management of the Grameen Bank 23

5. Progress of Bank Operations 32

6. Performance in Credit Operations 44

7. Economic Effects 55

8. Costs of Operation 70

9. Conclusions and Lessons of Experience 77

Appendix: Expenditure Patterns and the Market for Nonfarm Goods and Services 82

Bibliography 85

TABLES

1. Distribution pattern of rural landownership, 1979 and 1983/84 16

2. Changes in structure of labor force, 1973/74 to 1983/84 17

3. Distribution pattern of rural credit, by landownership group, 1982 22

4. Selected characteristics of the districts covered by the Grameen Bank 32

5. Coverage of the Grameen Bank, February 1987 33

6. Trends in disbursement and recovery of loans and accumulation in Group Fund and Emergency Fund, 1979-86 33

7. Trends in membership and borrowing, by sex of borrower, 1983-86 35

8. Trends in disbursement of loans, by sector, 1979-86 35

9. Disbursement of loans to male borrowers, by sector, 1979-86 36

10. Disbursement of loans to female borrowers, by sector, 1979-86 37

11. Major activities for which male borrowers took loans, 1983-85 38

12. Major activities for which female borrowers took loans, 1983-85 38

13. Distribution of trading sector loans, by origin of commodities, 1979-85 39

14. Loans disbursed for various types of collective enterprises, 1982-85 40

15. Utilization of the Group Fund, 1983-86 42

16. Distribution of Group Fund loans, by purpose for which loans were taken, 1979-85 43

17. Distribution of borrowers, by amount of cultivated land owned, 1985 44

18. Distribution pattern of landownership and landholding, 1985 45

19. Occupation of members and heads of household as stated on membership application form 47

20. Average size of current loans, by length of bank membership, 1985 48

21. Loan distribution, by purpose of loan and sex of borrower, 1985 49

22. Pattern of loan utilization, by sex of borrower, 1985 50

23. Pattern of loan utilization, by purpose of loan, 1985 51

24. Extent of overdue loans, by type of borrower, 1985 52

25. Distribution of borrowers, by overdue and paid installments, 1985 52

26. Statistical difference between project and control group households according to selected exogenous variables, 1984/85 56

27. Noninstitutional credit as a source of working capital, 1985 58

28. Amount of loans received from various sources, by different groups of rural households, 1984/85 58

29. Changes in working capital after joining Grameen Bank, by type of borrower, 1985 59

30. Accumulation of capital after joining Grameen Bank, by length of membership and sex of borrower, 1985 60

31. Effect of Grameen Bank on growth of equity capital, 1985 60

32. Changes in pattern of livestock ownership after intervention by Grameen Bank, 1985 61

33. Changes in occupation of borrowers after joining Grameen Bank, 1985 62

34. Labor force participation rates of members and nonparticipant groups, 1984/85 63

35. Increase in employment in activity for which loan was taken, by occupation and sex of borrowers, 1985 64

36. Borrowers' perception of change in their economic condition after joining Grameen Bank, 1985 65

37. Borrowers stated reasons for their improved economic condition after joining Grameen Bank, 1985 65

38. Level and structure of household income for Grameen Bank members and comparable nonparticipant groups, 1984/85 66

39. Annual household income in project and control villages, by landownership group, 1984/85 67

40. Estimates of proportion of poor population among participants and target-group nonparticipants, 1984/85 68

41. Expenditures on basic needs by Grameen Bank members compared with control groups, 1984/85 69

42. Shares of Grameen Bank funds from various sources, 1984-86 71

43. Changes in cost of Grameen Bank funds, 1984-86 71

44. Trends in use of Grameen Bank funds, 1984-86 72

45. Sources and composition of Grameen Bank income, 1984-86 72

46. Trends in cost of administration of loan operations, 1984-86 73

47. Unit costs of operation of bank branches, by age of branch, 1984/85 74

48. Profit-and-loss accounts, 1984-86 75

49. Expenditure pattern for all sample households, 1984/85 83

50. Marginal budget shares and expenditure elasticity of demand for different groups of sample households, 1984/85 84

ILLUSTRATIONS

1. Map of districts served by the Grameen Bank 13

2. The "Sixteen Decisions" program 28

FOREWORD

There is a growing recognition that institutional credit plays an important role in the modernization of agriculture through technological change. It is clear that as those processes of modernization occur, incomes rise and expenditures on locally produced goods and services expand in such a manner as to increase the demand for labor and labor-intensive entrepreneurial activities. The question then arises as to what extent institutional credit can be offered to very poor people to facilitate their taking direct advantage of the developing entrepreneurial activities.

Perhaps the most widely admired effort to answer this question is that of the Grameen Bank in Bangladesh. One of the commendable features of the Grameen Bank is its desire to have its experience intensely analyzed for the benefit of others who are considering such an effort, as well as for its own improvement.

Mahabub Hossain conducted this in-depth analysis as a staff member of the Bangladesh Institute of Development Studies, which undertook a comprehensive research project on evaluation of the Grameen Bank. The International Food Policy Research Institute, in connection with a range of collaborations with Mahabub Hossain and BIDS, is pleased to have provided support to him in the writing phase of this study of the Grameen Bank.

Particularly notable in the findings is the importance of the institutional philosophy that has been so ably implemented by the founder of the bank, Dr. Muhammad Yunus, through a complex management structure. Clearly, however, the scale of the bank's operations is now far beyond the pilot stage, so the lessons are real and important.

Related to the bank's philosophy is a set of costs that seem necessary to success. These costs are high and, although not unacceptable, suggest the possible need for some subsidization. The costs come to 26.5 percent of the loans and advances, using market rates for borrowed funds—that is about 10 percentage points higher than the substantial 16 percent rate charged. In noting this, emphasis must be given not only to the equity implications but to the development implications of bringing large numbers of low-income people into the discipline of economic development derived from a credit system that has virtually no overdues or bad loans. Indeed, in comparing the substantial costs of Grameen Bank lending, it is especially notable that rural credit systems in developing countries typically have overdues on the order of half the level of new loans. The Grameen Bank has an approach that keeps overdues and loan losses at close to zero.

These and a vast number of other economic issues are tackled in Mahabub Hossain's research report. In addition, BIDS is bringing out a number of reports on the impact of the bank relating to social and administrative issues. The findings in this study are important in that they are broad and detailed and will contribute to needed policy improvements in the rural credit programs of developing countries.

Rehman Sobhan
Director General, Bangladesh Institute
of Development Studies

John W. Mellor
Director, IFPRI

February 1988

ACKNOWLEDGMENTS

The field surveys for this study were conducted by the Bangladesh Institute of Development Studies, Dhaka. The contribution of Atiur Rahman and Rushidan Islam Rahman, who participated with the author in planning and implementing the survey, is gratefully acknowledged. The author is grateful to Rehman Sobhan, Director General of BIDS, and to Muhammad Yunus, Managing Director of the Grameen Bank, for providing institutional support. The report benefited from comments and suggestions made by John Mellor, Gunvant Desai, Hannan Ezekiel, Dayanatha Jha, Richard Meyer, and Muazzam Husain. Research assistance provided by Shamsun Nahar and Andrew Bernard is also gratefully acknowledged.

1

SUMMARY

The Grameen Bank is a specialized financial institution in Bangladesh that was established by government order in 1983 to provide credit to the rural poor for the purpose of improving their economic condition. The bank originated in 1976 as an action-research project in an area near Chittagong University to test the hypothesis that if the poor are supplied with working capital they can generate productive self-employment without external assistance. The bank now has a paid-up capital of Tk 72 million. Seventy-five percent of the shares are owned by the bank's borrower shareholders and 25 percent by the government. One member of a household that owns less than 0.5 acre of cultivable land or assets not exceeding the value of 1.0 acre of land is eligible to take loans from the bank. A loan is issued without any collateral and bears an interest rate of 16 percent a year.

The bank has progressed at a fast pace. By February 1987 it had opened 298 branches and mobilized nearly 250,000 households from 6 percent of the villages in the country. In the same period, it covered more than 25 percent of its target-group households in Tangail and Patuakhali districts, and 8-12 percent of the target group in the other three districts under its operation. At the end of 1986, the amount of outstanding loans stood at Tk 301 million. The yearly disbursement of loans increased from Tk 99 million in 1983 to Tk 542 million in 1986. The expansion of coverage of women, one of the most disadvantaged groups in rural society, has been impressive. At the end of 1986, women accounted for 74 percent of all members and 69 percent of outstanding loans. Nearly 98 percent of the new members mobilized during 1986 were women.

Loans from the Grameen Bank are used primarily for undertaking noncrop activities. In 1986, 46 percent of the loans were taken for livestock and poultry raising, 25 percent for processing and manufacturing activities, and 23 percent for trading and shopkeeping. The major activities financed are milch cow raising, paddy husking, cattle fattening, seasonal crop trading, paddy and rice trading, cattle and goat trading, handloom weaving, cloth trading, and grocery shop operating. With the increase in the proportion of women borrowers, who take loans mostly for livestock raising and paddy husking, the amount disbursed for livestock raising has increased.

Since 1982, credit has been issued to groups consisting of a number of borrowers for collective enterprises such as investing in irrigation machines, rice hullers, oil mills, and power looms; leasing markets; and leasing land for cooperative farming. The intent of these collective enterprise loans is to take advantage of improved technology and economies of scale, but they have had limited success, primarily because of difficulty in managing large groups and unfamiliarity with the enterprises. The share of the collective enterprise loans increased briskly from 1.9 percent in 1983 to 8.2 percent in 1984, but fell sharply during 1985 and 1986.

The bank has succeeded in reaching its target group. Only 4.2 percent of the members belong to households that own 0.5 acre or more of cultivable land. The target-group households that are left out are more numerous among agricultural wage laborers than among other occupational groups. About 60 percent of the Grameen Bank target group are agricultural-labor households, but agricultural labor was found to be the principal or subsidiary occupation for only 20 percent of members before they joined the bank.

The loan repayment performance is excellent. Only 0.5 percent of loans to 975 borrowers surveyed were overdue beyond one year, and overdue weekly installments (before the expiration of the one-year repayment period) were only 3.3 percent of the total amount borrowed. Most of the overdue loans were with nontarget-group members and repeat borrowers. Eighty-one percent of women borrowers had no overdue installments at the time of the survey, compared with 74 percent for men. A significant proportion of new borrowers pay installments in advance, presumably to get another and larger loan as early as possible. The main factors behind the excellent recovery of Grameen Bank loans are (1) the ability of the bank to confine credit services to the extremely needy; (2) the strong management system developed by the bank's founder-managing director, including decentralization of power and responsibilities, and intensive training of bank workers; (3) the provision of loans for activities that generate regular incomes; (4) the collection of repayments in small amounts, suitable to the circumstances under which the poor earn and live; and above all, (5) the dedicated services of the bank workers, who are strongly motivated by the dedication of the managing director and regard their work as an opportunity to serve the poor rather than simply to earn an income for themselves.

The Grameen Bank has a pervasive effect on the credit market in the area of its operation. Very few of the bank's target group get credit from formal lending agencies, and only about a fifth of them are served by informal lenders. With Grameen Bank intervention, the proportion of households receiving institutional credit increases to about a third—almost two-thirds among the target group. The share of Grameen Bank credit in total loans taken by all households in five randomly selected villages was 78 percent in 1984/85. Most of the institutional credit outside the bank went to the nontarget-group households.

The most direct effect of the Grameen Bank has been on the accumulation of capital by the poor. The amount of working capital employed by members' enterprises increased by an average of three times within a period of 27 months. The investment in fixed assets is about 2.5 times higher for borrowers with more than three years' membership than for those who joined during the year of the survey. The number of cattle owned per 100 borrowers increased from 61 before joining the bank to 102 at the time of the survey—an increase of 26 percent a year.

Grameen Bank loans help to generate new employment, particularly for poor women. About a third of the members reported that they were unemployed before joining the bank—almost 7 percent of the men and about 50 percent of the women. With the loans, these members generated self-employment in activities of their choice.

An in-depth household survey in five project villages and two control villages found that Grameen Bank members had incomes about 43 percent higher than the target group in the control villages, and about 28 percent higher than the target-group nonparticipants in the project villages. This positive income effect is mainly due to large increases in income from processing and manufacturing, trading, and transport services financed by the bank loans. A comparison of the incomes of different landownership groups in the selected project and control villages shows that the positive income effect has been highest for the absolutely landless, followed by the marginal landowners, but the income of the nontarget group is lower in the project villages than in the control villages, and the difference is largest for the higher-landownership groups. This variation indicates that the increase in income of the poor is partly due to a redistribution of income from the rich. But it appears that Grameen Bank intervention also leads to significant additions to rural incomes. While the project and control villages have similar endowments of land and of male workers, average household income is found to be one-sixth higher in the project villages than in the control villages. The extreme poverty-stricken population is 48 percent among Grameen Bank participants, compared with about 75 percent among nonparticipants in the target group in both project and control villages.

Thus the Grameen Bank has made a positive contribution to the alleviation of poverty in its area of operation. But the bank has so far covered only about 4 percent of its target-group households throughout Bangladesh. The issues are whether it can be expanded to a wide-enough scale to have a significant effect on the alleviation of rural poverty in Bangladesh and whether the model can be replicated in other countries.

The main factors that could affect successful expansion of the bank are the market for nonfarm goods and services, institutional development and stability, and costs of operation.

The present weak market for nonfarm goods and services, at the low levels of income prevailing in Bangladesh, may not pose a serious problem to expansion of the bank. It is now well recognized that with agricultural growth, the market for nonfarm goods and services is stimulated through linkage effects. The Grameen Bank target group is about half of the national population, and as their incomes rise, they will start demanding each other's products and services, thus expanding the market.

Over the last three years, the bank has made good progress in building a stable institution with the capacity to maintain the present high morale of the staff. As a result of expansion, a decentralization of administration has taken place, with responsibilities and decisionmaking powers vested in a dedicated cadre of midlevel officials that was developed during the 1976-82 period of experimentation with the project. Incentives for hard work have been maintained through quick promotion and transfers based on performance in the field.

Because of intensive supervision of borrowers and participation of bank workers in social development activities, the operating costs of Grameen Bank are very high. For 1986 the cost of loan operations is estimated at 21.7 percent of the loans and advances at the actual cost of funds to the bank, which is highly subsidized by two loans from the International Fund for Agricultural Development (IFAD). This cost would be 26.5 percent if the bank had to borrow at the same rate as the other financial institutions in the country.

The implicit rate of subsidy on loan operations is estimated at 39 percent at the actual cost of the funds, and 51 percent at the opportunity cost. The bank has so far managed on its own by keeping part of its low-cost loanable funds in fixed- and short-term deposits with other banks, and the profits from these financial transactions have made up the losses from loan operations. But this practice cannot be counted on as a long-term source of income. The high cost may constrain the expansion of the bank unless it decides to increase the rate of interest charged on the loan or to reduce the cost by providing more large loans (for example, collective enterprise loans), moving into agricultural credit for small farmers, and embarking on deposit-banking on a large scale.

The Grameen Bank concept of generating self-employment for the poor through credit without collateral should work in other countries with widespread poverty and underemployment. Some elements of the Grameen Bank approach to delivery of credit, such as formation of small homogeneous groups for group guarantee of loans and supervision of loan utilization, recovery of loans in small regular installments, and development of institutions of collective savings for mutual benefit of members, may also work in other environments. But elements like taking the bank to the people and intensive interaction of bank staff with borrowers may be inappropriate and highly expensive for sparsely settled areas with underdeveloped transport systems. For such environments, an appropriate delivery mechanism has to be worked out. Indeed, one of the lessons of Grameen Bank is that an appropriate institution can be developed only after considerable experimentation, through a thorough understanding of the physical and socioeconomic environments.

2

INTRODUCTION

Bangladesh has been experimenting with a rural credit program for the extreme poor that is known as the Grameen Bank. The word *grameen* means village, but the Grameen Bank is different from the agricultural development bank (Bangladesh Krishi Bank or BKB) and commercial bank branches located in villages. The Grameen Bank is a target-group-oriented credit institution set up to provide loans to rural households that own less than 0.5 acre of land.

The Grameen Bank was initiated in 1976 as an action research project in a village near Chittagong University by a professor of economics who is currently the bank's managing director. After an experimental period of three years, the project was replicated in five districts of Bangladesh (see Figure 1) during 1979-82, in collaboration with rural branches of commercial banks and BKB, and with financial assistance from the Bangladesh Bank (the state bank of Bangladesh) and the International Fund for Agricultural Development (IFAD). The project was transformed into a specialized credit institution by a government ordinance in September 1983. Since then it has expanded rapidly. By February 1987 the Grameen Bank had opened 298 branches covering more than 6 percent of the villages in the country.

The Grameen Bank organizes the poor in groups and associations and provides credit without collateral at the same rate of interest (16 percent a year) as other commercial banks. It supervises utilization of the loans and guides borrowers (members) in all-around socioeconomic development. Loans are made to individuals for a maximum of Tk 5,000.[1] Nearly three-fourths of the borrowers are women. The bank has succeeded in recovering 98 percent of the loans and in substantially improving the economic condition of member households.

Since the Grameen Bank is a rare success story in the history of rural credit experiments in the developing world, it generates curiosity and hope in other developing countries among policymakers who would like to use credit as an antipoverty program. A thorough evaluation of the initial experience of the bank may thus be useful at this stage. Such an evaluation is the purpose of this study, which aims to describe the organization and management of the Grameen Bank, evaluate its credit operations, and assess the bank's effect on alleviation of poverty.

Sources of Information

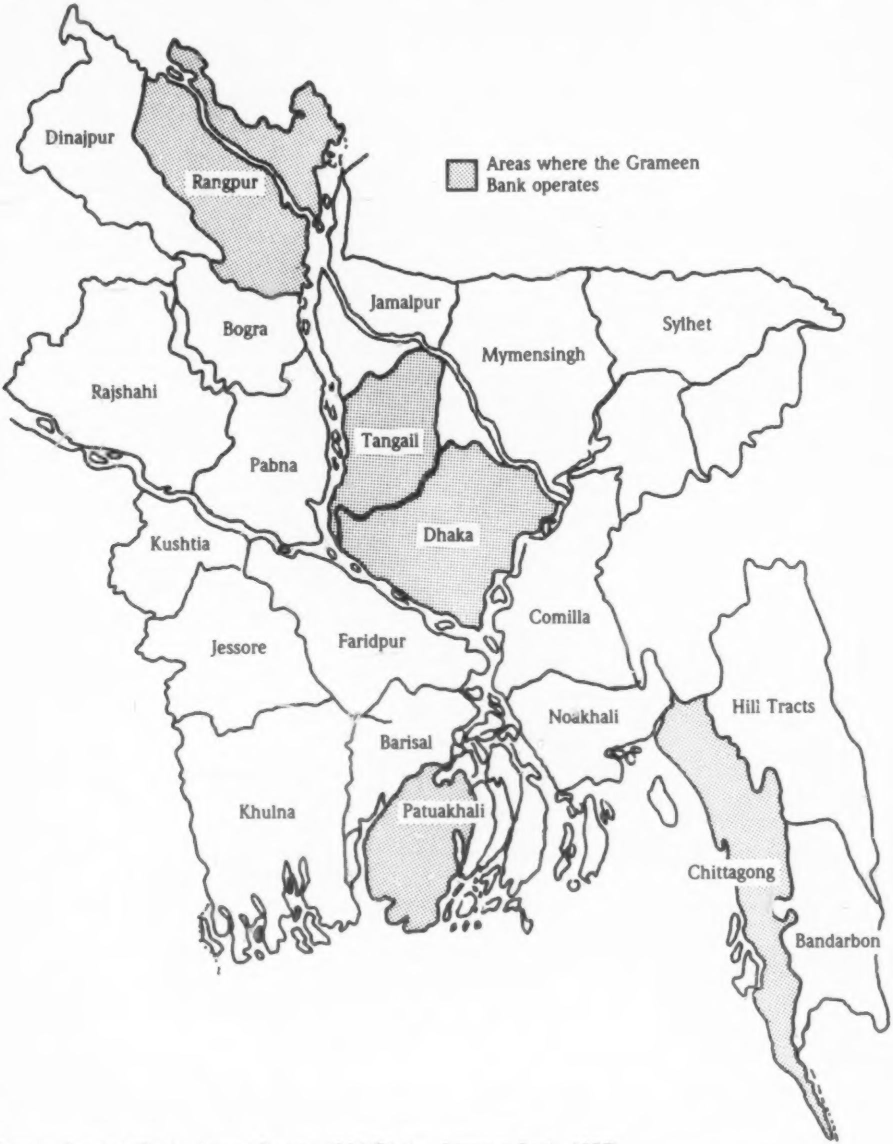
The study was undertaken by the author in May 1985 at the request of the Grameen Bank and is a follow-up of an earlier study that investigated the performance of the bank up to the end of 1983.[2] The data were collected through field surveys of borrowers and an in-depth household survey in selected project and control villages. Data generated by the bank as a part of its management information system, which is well de-

---

[1] In June 1987, one Bangladesh taka (Tk) was equivalent to U.S. $0.032.

[2] Mahabub Hossain, *Credit for the Rural Poor: The Grameen Bank in Bangladesh,* Research Monograph 4 (Dhaka: Bangladesh Institute of Development Studies, 1984).

Figure 1—Map of districts served by the Grameen Bank


Dinajpur
Rangpur
Areas where the Grameen Bank operates
Jamalpur
Bogra
Sylhet
Mymensingh
Rajshahi
Tangail
Pabna
Dhaka
Kushtia
Comilla
Jessore
Faridpur
Noakhali
Hill Tracts
Barisal
Khulna
Patuakhali
Chittagong
Bandarbon

Source: Grameen Bank, *Annual Report, 1986* (Dhaka: Grameen Bank, 1987).
Note: An administrative reorganization in 1982 created 64 new districts out of 21 old districts.

veloped compared to that of other institutions in Bangladesh, have also been used. The survey methodology is described below.

Branches more than one year old in May 1985 were classified in two groups according to age: those from one to three years old and those more than three years old. Ten percent were randomly selected from the first group and 20 percent from the second group. This selection produced a total of 15 branches, 5 of them from the older group. A list of all villages covered by the selected branches was obtained from the Grameen Bank, and one village was randomly selected from each of the branches. All current borrowers belonging to the selected villages were interviewed, using a structured questionnaire. The sample consisted of 975 borrowers. This survey was conducted during July and August 1985.

To assess the effect of the Grameen Bank on the economic condition of borrower households, five villages selected from the older branches were taken as project villages. In addition, two control villages were selected, keeping in mind similarities of land distribution and occupation structure between project and control villages. First, a census was undertaken in these seven villages to collect information on landownership and occupation. The households were then randomly stratified into four landownership groups and two occupation groups (farm and nonfarm) within each landownership group. A proportional random sample was then drawn from each of the eight strata to get 40 sample households from each village. The total sample size for this survey thus consisted of 280 households. They were interviewed to collect detailed information on employment, assets, income, expenditure, and investment. This survey was conducted from September to November 1985, and the data refer to fiscal year 1984/85.[3] The author was involved in the design and administration of both surveys.

Organization of the Report

As a background to the study, Chapter 3 describes the socioeconomic environment under which the Grameen Bank works. Information is provided on the extent of landlessness and poverty, the organization of production and the employment situation for the poor, and the access of the poor to capital markets. This information may be useful in appreciating the factors that have contributed to the success of the Grameen Bank and the conditions for its successful replicability in other countries. Also important to the bank's success was the building of an appropriate institutional and organizational structure that could cater to the needs of the poor. The organization and management of the bank are briefly described in Chapter 4.

Historical information about the progress of the bank in disbursing and recovering loans, the relative importance of different activities financed, and the utilization of a savings fund created for the borrowers is presented in Chapter 5. Chapter 6 reports the findings of the borrower survey regarding the success of the bank in reaching its target group, the pattern of utilization of loans, and the repayment behavior of the borrowers. Chapter 7 then analyzes the effect of the bank on employment, capital accumulation, income, and the standard of living for the rural poor.

Since the Grameen Bank is an intensively managed credit program and is also engaged in socioeconomic development of its clientele, costs of operation are expected to be high. Chapter 8 takes up this issue and estimates the operating costs of the bank in order to assess the implications for subsidies in credit programs for the poor. Finally, Chapter 9 draws some lessons from the experience of the Grameen Bank and discusses both the constraints to expansion of the program and the possibility of its replication in other countries.

---

[3] In Bangladesh, the fiscal year and agricultural year are the same.

3

SOCIOECONOMIC ENVIRONMENT AND THE ROLE OF CREDIT

Landlessness and Poverty

Bangladesh is an extremely land-scarce country. In 1987 it supported over 100 million people within an area of 56,000 square miles. Nearly two-thirds of its 35 million acres of land are already cultivated; the remainder is under forests, rivers, and homesteads.[4] There is little scope for expanding the cultivated area, which has remained at 22.2 million acres since the early 1960s. The 1983/84 agricultural census found that the average size of a farm had declined from 3.53 acres in 1960 to 2.25 acres in 1984.[5]

Because of the extreme pressure of population on land, the incidence of landlessness is high. In 1983/84 only 3.8 percent of rural households owned 7.5 acres or more and another 16.3 percent owned 2.5-7.5 acres (see Table 1). Households with no land at all were relatively few, since shelter requires a parcel for a homestead, but the number of marginal landowners is vast. Households with less than 0.5 acre were estimated at 6.4 million—about 46 percent of all rural households in 1983/84. In Bangladesh, households with less than 0.5 acre are considered functionally landless, since the amount of land they own cannot be a significant source of income.

Until recently, the landless were growing at a faster rate than the population—the exact magnitude of the growth is disputed because comparable time series data are not available.[6] For 1960 the number of rural households was estimated at 9.1 million, of which 3.8 million were functionally landless. By 1979 these numbers had increased to 12.9 and 6.3 million, respectively. Thus the landless grew at 2.7 percent a year compared with 1.9 percent for all rural households. In recent years, however, the situation may have improved because of rapid urbanization and relatively greater movement of the absolutely landless households to urban areas. During 1979-84, the number of absolutely landless households declined from 2.0 to 1.2 million, while the number of marginal landowners increased from 4.3 to 5.2 million—a rate of increase of 4.4 percent a year, compared with a 1.6 percent increase in the number of all rural households.

Many recent studies have reported that during the 1970s, two-thirds to three-fourths of the rural population suffered from absolute poverty, and the magnitude of poverty had deepened compared with that of the 1960s.[7] The 1970s also witnessed a severe

---

[4] Bangladesh, Bureau of Statistics, *1986 Statistical Yearbook of Bangladesh* (Dhaka: Government Press, 1986).

[5] Bangladesh, Bureau of Statistics, *The Bangladesh Census of Agriculture and Livestock: 1983-84,* vol. 1 (Dhaka: Government Press, 1986).

[6] Steve Jones, "An Evaluation of Rural Development Programs in Bangladesh," *The Journal of Social Studies* 6 (December 1979): 51-92; Mosharaf Hossain, A. Rashid, and S. Jahan, *Rural Poverty in Bangladesh: A Report to the Like-Minded Group* (Dhaka: Universities Research Center, 1986); and Mahabub Hossain, "A Note on the Trend of Landlessness in Bangladesh," *The Bangladesh Development Studies* 14 (June 1986): 93-100.

[7] A. R. Khan, "Poverty and Inequality in Rural Bangladesh," in *Poverty and Landlessness in Rural Asia,* ed. International Labour Organisation (Geneva: ILO, 1977), 137-160; M. Muqtada, "Poverty and Inequality: Trends and Causes," in *Bangladesh: Selected Issues in Employment and Development,* ed. R. Islam and M. Muqtada (New Delhi: International Labour Organisation, Asian Employment Program, 1986), pp. 41-60; and I. Islam and H. Khan, "Income Inequality, Poverty and Socio-Economic Development in Bangladesh," *The Bangladesh Development Studies* 14 (June 1986): 75-92.

Table 1—Distribution pattern of rural landownership, 1979 and 1983/84

Size of Land Owned	1979 Land Occupancy Survey		1983/84 Agricultural Census		Annual Rate of Growth, 1979-84
	Number of Households	Share of Households	Number of Households	Share of Households	
(acres)	(thousands)	(percent)	(thousands)	(percent)	
None	1,979	15.4	1,198	8.7	−10.5
Less than 0.50	4,286	33.3	5,201	37.6	4.4
0.50–0.99	1,516	11.8	1,660	12.0	2.0
1.00–2.49	2,660	20.7	2,979	21.6	2.5
2.50–4.99	1,436	11.2	1,598	11.6	2.4
5.00–7.49	501	3.9	650	4.7	6.0
7.50–14.99	374	2.9	415	3.0	2.4
15.00 or more	114	0.9	117	0.8	0.6
Total	12,866	100.0[a]	13,818	100.0	1.6

Sources: Bangladesh, Bureau of Statistics, *Statistical Pocket Book of Bangladesh, 1985* (Dhaka: Government Press, 1985), p. 211; and Bangladesh, Bureau of Statistics, *The Bangladesh Census of Agriculture and Livestock: 1983-84,* vol. 1 (Dhaka: Government Press, 1986), p. 98.

[a] Parts do not add to total because of rounding.

downward trend in real wages for agricultural workers. However, the 1981/82 Household Expenditure Survey shows significant improvement in the poverty situation in the early 1980s.[8] The real wage for agricultural laborers also has shown a consistent upward trend since 1982. In 1986 the daily nominal wage could buy 3.5 kilograms of rice—44 percent more than during the 1975-82 period, and 25 percent more than in 1970, just before the independence of the country. But the proportion of poor population was still about 60 percent in 1981/82, which must be considered high by any standard.

The links between landlessness and poverty are widespread underemployment and low productivity of labor. The labor force surveys in Bangladesh report very little open unemployment (Table 2), because people often find part-time and short-duration work and family laborers share work generated by the household. The average duration of work is also estimated at high levels. The 1983/84 labor force survey recorded that in rural areas, an employed person worked an average of 52 hours during the week preceding the date of the survey.[9] But a large proportion of such labor would be of very low productivity. Since the poor cannot afford to remain unemployed, and the wage rate is low, they engage in various types of self-employment and work beyond normal hours to supplement their meager household income.

Farming as a Source of Employment

The labor-absorption capacity of the agricultural sector is limited. Seventy-nine percent of the labor force reported agriculture as their primary occupation in 1974, but many have since moved out of agriculture, reducing its share to 59 percent by 1983/84 (Table 2). Agriculture's share of the rural labor force declined from 86 percent to 72 percent during 1974-84. Information on national employment in crop farming is lacking. Based on norms of fixed labor coefficients derived from village studies, it is estimated that an agricultural

---

[8] Bangladesh, Bureau of Statistics, *Report of the Bangladesh Household Expenditure Survey, 1981-82* (Dhaka: Ministry of Planning, 1986).

[9] Bangladesh, Bureau of Statistics, *Final Report: Labor Force Survey, 1983-84* (Dhaka: Government Press, 1986).

Table 2—Changes in structure of labor force, 1973/74 to 1983/84

Labor Category	1973/74 Millions of Persons	1973/74 Share of Total	1983/84 Millions of Persons	1983/84 Share of Total	Annual Rate of Growth
		(percent)		(percent)	(percent)
Labor force	21.93	100.0	28.47	100.0	2.7
Unemployed	0.52	2.4	0.49	1.7	−0.6
Employed	21.41	97.6	27.98[a]	98.3	2.7
Rural	19.20	87.6	22.20	78.0	1.5
Urban	2.21	10.0	5.80	20.3	10.1
Employed in nonagriculture	4.57	20.8	11.53	40.5	9.7
Rural	2.67	12.3	6.25	22.0	8.9
Urban	1.90	8.5	5.28	18.5	10.8

Sources: Bangladesh, Bureau of Statistics, *Final Report: Labor Force Survey, 1983-84* (Dhaka: Government Press, 1986).

Note: The 1983/84 figures have been adjusted to include rural towns in urban areas. The 1973/74 figures are adjusted for undercounts detected in the postcensus enumeration checks.

[a] Parts do not add to subtotal because of rounding.

worker would have been employed in crop farming for 158 days during 1984/85.[10]

The wage employment generated in farming activities is even less adequate for functionally landless (less than 0.5 acre) households. The small farm (less than 2.5 acres) can meet most of the required labor with family workers, and large landowners (with 7.5 acres or more) cultivate a part of their holdings with peasant sharecroppers, thereby reducing the need to hire labor. Thus the size of the agricultural labor market is small and is gradually shrinking because of the increasing availability of family workers associated with the growing pressure of population on land. It is estimated from a recent household survey that nearly four-fifths of farm households hire labor at some time because of the seasonality of agricultural operations, but only one-fourth of the available agricultural labor is hired.[11] On the supply side, two-thirds of the functionally landless households participate in the agricultural labor market, and the participating households receive employment from the market for about 160 days a year.

With existing technology, labor productivity in farming is low and payment to hired labor is meager. In 1984/85, value added from crop production was Tk 15,000 per farm household against an estimated employment of 225 days per farm, which gives a labor productivity of Tk 67 per eight-hour standard day. At this rate, a six-member farm household would have to work for 310 days to earn a poverty-level income for the household. The hired workers are paid a wage rate that is less than a half of the average labor productivity. The nominal wage rate for agricultural workers in 1984/85 was Tk 25 per day. At this rate, a five-member landless household would have to work for 690 days a year to earn the poverty-level income. This amounts to about 400 days per worker in the household.[12] The compulsion on the part of the poor to generate self-employment so that they can utilize available surplus labor and can work beyond standard hours is thus understandable.

---

[10] M. Muqtada, "Determinants and Possibilities of Employment Expansion in the Crop Sector," in *Bangladesh: Selected Issues in Employment and Development,* ed. R. Islam and M. Muqtada (New Delhi: International Labour Organisation, Asian Employment Program, 1986), pp. 61-88.

[11] Mahabub Hossain, *Nature and Impact of Modern Rice Technology in Bangladesh,* Research Report 68 (Washington, D.C.: International Food Policy Research Institute, forthcoming).

Agricultural Growth Linkage and Expansion of the Rural Nonfarm Sector

In view of the above, it could be argued that the landless are being pushed out of agriculture and that the urban informal sector and the rural noncrop activities are operating as their "employers of last resort." These activities enable labor-surplus households to transform nonmarketed labor into commodities and marketable services. The expansion of the rural nonfarm sector would then be constrained from the demand side. If the demand for nonfarm goods and services did not increase as fast as the supply, prices would fall and the increased flow of labor into the sector would reduce labor productivity.

Agricultural growth following the diffusion of the new "seed-fertilizer-water" technology may, however, stimulate the demand for nonfarm goods and services.[13] In Bangladesh, regional concentration of irrigation and the availability of the new technology mostly for rice and wheat has led to specialization of cereal production in irrigated areas and production of noncereal crops in nonirrigated areas. This implies larger movement of agricultural commodities across regions and increased demand for trading and transport services. The diffusion of the new technology may have created opportunities for investment in rural nonfarm activities through its effect on the demand for (1) agricultural inputs such as fertilizer, pesticides, irrigation equipment, fuel, and spare parts produced in the nonagricultural sector; (2) services for processing and marketing additional surplus produce; and (3) trading and transport services to handle the additional purchase of nonfarm goods. Also, livestock and fisheries products and rural services have very high income elasticity of demand, so with the growth of agricultural income the share of these commodities in the rural consumption basket increases more than proportionately.[14]

Rapid rural-urban migration itself creates jobs in the rural nonfarm sector. In Bangladesh, urbanization is going on at a rapid pace. The proportion of urban population increased from only 5 percent in 1961 to 17 percent in 1981. The enlarged urban market has stimulated the growth of marketed surplus and increased the flow of urban goods to rural areas. The marketed surplus of rice increased from about 10 percent in the early 1960s to nearly 40 percent in 1984/85.[15] According to a recent transport study,[16] the volume of freight traffic increased by 5 percent a year and the volume of passenger traffic by 7 percent a year during 1976-85. The demand for trading and transport services would increase correspondingly.

---

[12] The average size of the household and number of family workers assumed for this calculation are those observed in village studies. The poverty level income for 1984/85 is taken as 10 percent higher than that estimated for 1983/84. The retail price of coarse rice has actually increased in recent years by about 10 percent a year.

[13] John W. Mellor, *The New Economics of Growth* (Ithaca, N.Y.: Cornell University Press, 1976).

[14] For rural Bangladesh, the expenditure elasticity of demand is estimated at 1.6 for livestock and fisheries products, 1.4 for industrial goods, and 1.6 for construction, trading, transport, and other services, compared to 0.7 for food crops. See Mahabub Hossain, "Agricultural Growth Linkages—The Bangladesh Case," *The Bangladesh Development Studies* 15 (March 1987): 1-30.

[15] Bangladesh, Bureau of Statistics, *Monthly Economic Situation in Bangladesh* (Dhaka: Government Press, December 1985); and Bangladesh, Bureau of Statistics, *Master Survey of Agriculture (Second Round)* (Dhaka: Government Press, 1964).

[16] Bangladesh, Planning Commission, "Intermodal Transport Study: Final Report," as quoted in *The Third Five-Year Plan, 1985-90* (Dhaka: Government Press, December 1985).

Organization of Nonfarm Production and the Poor

A majority of the organizers of rural nonfarm activities come from lower-income households. According to the 1983/84 agricultural census,[17] 6.7 percent of rural households operated cottage industries; the proportion was 10.8 percent for the landless, 6.9 percent for those operating less than 2.5 acres, and 3.7 percent for households operating 7.5 acres or more. A 1982 survey of 16 villages found that 40 percent of rural households were engaged in transport and construction activities and 30 percent in various rural services.[18] For the functionally landless group, the estimate was 54 percent in transport and construction and 40 percent in rural services. The inverse relationship between self-employment in rural nonfarm enterprises and the size of landownership has also been reported by other village studies.[19]

A number of hypotheses can be put forward to explain the relative advantages, in the initial stages of development, of small-scale organization of production around the household over large-scale production along capitalist lines.

First, at low levels of income, the size of the market for nonfarm goods and services is so small and thinly spread over a wide area that large-scale organization of production may be uneconomic owing to underutilization of capacity of indivisible assets. For example, a petty trader carrying goods on a headload may operate more economically in a village *hat* than a large trader transporting goods on carts, boats, or trucks. (A *hat* is a marketplace where people assemble once or twice a week. On average, one *hat* serves a population of about 9,000 people from a cluster of eight villages.)

Second, in the environment of underdeveloped infrastructure facilities, the high unit cost of transport may prohibit movement of goods necessary to exploit the market of a wider area if production has to be organized on a large scale. The household, on the other hand, can limit production to an amount that can be sold within the locality or be transported to the *hat* on headloads of the producer without incurring any transport cost. This may be an important reason behind the dispersion of traditional cottage occupations, such as potter, blacksmith, carpenter, and matmaker, to almost every village, thus making each village a self-sufficient production and consumption unit at the phase of development when the market is thin and the infrastructure is undeveloped.

Third, the demand for such goods and services may be seasonal, with peaks occurring during post-harvest periods when farmers sell their products and buy nonfarm goods with the cash income. Trading activities fluctuate even within a week; in most areas, transactions take place in a *hat* held once or twice a week. In this environment, the household has more flexibility in reallocating family labor among different occupations according to the pattern of demand than does a firm hiring workers on a full-time basis. Thus, a hired worker of a specialized firm is more likely to be underemployed than is a family worker engaged in a number of activities that the household organizes.

Fourth, under conditions of widespread underemployment and poverty, the opportunity cost of employing family labor may be considerably less than the wage rate. Because of institutional norms, hired laborers work for a specified period of the day (usually from eight o'clock in the morning to four in the afternoon). But a household that attaches high cost to leisure because of poverty can extend working hours by employing family workers beyond normal hours. Maintenance of livestock and poultry is an activity that can be done by using family labor during slack times without sacrificing the opportunity of wage employment. In Bangladesh, a large proportion of workers in cottage industries are women who, because of socioreligious factors, do not look for employment outside the home. Cottage industries and petty trade are often secondary occupations of men who work during evenings or slack periods of their primary occupation.[20] Since such family labor has low opportunity cost, the real rate of return on capital for organizing nonfarm activities is higher for a household than for a firm that must deduct the wages paid to hired workers before estimating the profit.

---

[17] Bangladesh, *Census of Agriculture and Livestock: 1983-84.*

[18] Hossain, *Nature and Impact.*

[19] See, for example, Bangladesh Institute of Development Studies, *Rural Industries Study Project—Final Report* (Dhaka: BIDS, 1981), Chap. 3.

The Role of Credit

Generation of self-employment in nonfarm activities may require investment in working capital and basic skills in reading, writing, and arithmetic. The poor may be constrained in taking up such employment opportunity by lack of financial resources and necessary human capital. The amount of financial capital required may be small, but at very low levels of income it is difficult to accumulate even that amount. Although development of human capital involves a long-term program, working capital can be provided to the poor through financial institutions.

Under certain circumstances, loans can help the poor to accumulate their own capital. Baker and Hopkin show that the relationship between the growth in equity capital and credit is governed by the following:[21]

$$\Delta E/E = [(D/E)(r - i) + r]\,(1 - c),$$

where D is the amount of loan; E is the amount of equity capital, that is, the difference between the value of assets and the loan; r is the rate of return on assets; i is the rate of interest paid on the loan; and c is the rate of consumption out of the income from the asset. As long as the rate of return on assets is higher than the rate of interest on the loan, credit will increase family income. The higher the share of the loan in total capital (D + E), the higher will be the growth of income of the household. If the marginal propensity to consume is unity, the amount of equity capital will be unchanged, but if it is less than one, the loan will increase the net worth of the household. Under normal circumstances, the poor may find it very difficult to save, but if the credit program is such that the loan and the interest are recovered in small installments over a period of time, the loan may force compulsory regular saving of small amounts that would otherwise be consumed under the pressure of poverty.

But credit is rarely available to the poor at reasonable rates of interest. Commercial banks fail to cater to the credit needs of the poor for three main reasons. First, these banks require collateral, which the poor find difficult to provide; second, their procedures for filling in application forms and completing other formalities for obtaining loans are too cumbersome for the illiterate poor; and third, they prefer handling large loans rather than the petty loans that the poor need. The general experience of the small farmer credit program, which has long been popular with governments of most developing countries, has been limited success in reaching the target group.[22]

---

[20] The 1979 BIDS survey of rural industrial enterprises in 11 *upazilas* (the lowest-level administrative unit, which was previously called *thana)* found that women constituted 34 percent of workers in enterprises located in villages, compared with only 6 percent in enterprises located in rural towns. Male workers employed in rural industries worked an average of 319 days a year, of which 188 days (59 percent) were spent in industrial occupations. In low-productivity industries, such as mat making, bamboo and jute processing, and rice processing by wooden husker, industry provided employment to male workers for 125 days. Female workers, on the other hand, worked for 287 days a year, of which 276 days (96 percent) were spent in industrial occupations. See Mahabub Hossain, "Employment and Labour in Bangladesh Rural Industries," *The Bangladesh Development Studies* 12 (March-June 1984): 1-24.

[21] C. B. Baker and J. A. Hopkin, "Concepts of Finance Capital for a Capital-Using Agriculture," *The American Journal of Agricultural Economics* 51 (December 1969): 1055-1064.

In Bangladesh the number of rural branches of commercial banks and the agricultural development bank has increased greatly in recent years, from 854 in 1975/76 to 3,225 in 1983/84.[23] The amount of credit disbursed by these institutions increased from Tk 461 million to Tk 10,087 million during this period, but the loans were received by a few medium and large landowners. A survey conducted by the International Fertilizer Development Center (IFDC) among 2,400 randomly selected households noted that in the 1982 boro rice season (when the input-intensive, high-yielding paddy is grown), only 4.6 percent of the farmers received credit from institutional sources. The proportion was 1.2 percent for farmers with landholdings of less than 1.0 acre, compared with 7.7 and 7.2 percent, respectively, for farmers with medium (2.5 to 5.0 acres) and large (over 5.0 acres) holdings.[24] The picture was similar for other crop seasons. For the 1981/82 crop year, 13.6 percent of the farmers received credit from institutional sources; for the marginal landowning group, the estimate was 5.4 percent.

The joint review of agricultural credit conducted by the government of Bangladesh and the International Development Association also noted that loans disbursed by financial institutions went mostly to households owning 3 to 9 acres of land.[25] The findings of a 1982 household survey conducted jointly by the Bangladesh Institute of Development Studies (BIDS) and the International Food Policy Research Institute (IFPRI) in 16 villages are reported in Table 3.[26] The survey collected information on a quarterly basis on loans obtained by the sample households from both institutional and informal sources. It was found that only 14 percent of the households received credit from institutional sources; this is similar to the findings of the IFDC survey.[27] The institutional sources provided one-fourth of the total loans taken by the sample households. Only 7 percent of the functionally landless group could tap the institutional sources, which accounted for 8 percent of the total loans taken by them. The extremely limited access of the poor to financial institutions is aptly demonstrated by the above information.

The poor, however, have access to informal sources of loans: professional moneylenders known as *mohajons*, well-to-do farmers, friends, and relatives. Table 3 shows that 62 percent of the rural households obtained loans from these sources, and their importance was higher for the smaller landowning groups. Nearly 92 percent of the functionally landless households were dependent on these sources for about 92 percent of total loans. But these sources charge very high rates of interest. The BIDS/IFPRI study[28] found that in two-fifths of the cases, loans from informal sources were provided

---

[22] For an excellent review of the small farmer credit program in developing countries, see U.S. Agency for International Development, *Small Farmer Credit: Analytical Papers*, vol. 19 (Washington, D.C.: Department of State, 1973).

[23] A. M. A. Rahim, "Agricultural Credit Institutions and Policies in Bangladesh," *The Bangladesh Journal of Agricultural Economics* 8 (June 1985): 17-34; Mahabub Hossain, "Institutional Credit for Rural Development: An Overview of the Bangladesh Case," *The Bangladesh Journal of Agricultural Economics* 8 (June 1985): 1-16.

[24] International Fertilizer Development Center, *Agricultural Production, Fertilizer Use and Equity Considerations: Results and Analysis of Farm Survey Data; 1980-82, Bangladesh* (Muscle Shoals, Ala.: IFDC, 1984), pp. 67-70.

[25] Bangladesh/International Development Association, *Bangladesh Agricultural Credit Review* (Dhaka: Government of Bangladesh/IDA, 1983).

[26] For details about the survey see Bangladesh Institute of Development Studies/International Food Policy Research Institute, *Development Impact of the Food for Work Program in Bangladesh*, a report prepared for the World Food Programme (Washington, D.C.: BIDS/IFPRI, 1985).

[27] IFDC, *Agricultural Production.*

[28] BIDS/IFPRI, *Development Impact of the Food for Work Program.*

Table 3—Distribution pattern of rural credit, by landownership group, 1982

Landownership Group	Households Receiving Loans: Institutional Sources	Households Receiving Loans: Informal Sources	Amount of Loans Obtained per Household: Institutional Sources	Amount of Loans Obtained per Household: Informal Sources	Share of Total Loans Obtained from Institutional Sources
(acres)	(percent)		(Tk/year)		(percent)
Functionally landless (up to 0.49)	6.8	91.6	81	936	8.0
Small owner (0.50–1.99)	15.0	55.9	226	841	21.2
Medium owner (2.00–4.99)	20.0	46.9	504	963	34.4
Large owner (5.00 or more)	21.0	29.0	929	1,493	38.4
All households	14.3	61.7	323	964	25.0

Sources: Compiled from information in Raisuddin Ahmed and Mahabub Hossain, "Infrastructure and Development of a Rural Economy," International Food Policy Research Institute, Washington, D.C., 1987 (mimeographed).

Note: These figures are estimates based on a survey of 640 randomly selected households in 16 villages that was conducted jointly by the Bangladesh Institute of Development Studies and the International Food Policy Research Institute in 1982.

free of interest,[29] but for the remaining cases the average rate of interest charged was estimated at 125 percent a year. In contrast, the average rate of interest paid on loans from institutional sources was 14.6 percent a year. The high rate of interest severely limits the production activities that can be undertaken with the loans. Therefore, high-interest credit from noninstitutional sources basically finances consumption, for which the poor are forced to take very short-term loans when their physical existence is at stake.

Faced with shortage of capital, many nonfarm operators often borrow raw materials in kind from the *mohajons* against the stipulation of compulsory delivery of output to the lender. Such transactions usually involve higher prices for raw materials and lower prices for output, compared with the market, and the implicit interest charges claim a large proportion of the potential income of the borrower.[30] Also, lack of access to capital sometimes forces the poor with necessary skills to organize nonfarm enterprises in "partnership" with the rich whose only involvement in the activity is the contribution of capital. The income obtained by the poor in such enterprises may not be higher than the imputed value of the family labor at the wage rate prevailing in the market. Supply of capital at "reasonable" rates of interest could thus make a significant dent in the life of the rural disadvantaged groups.

---

[29] Raisuddin Ahmed and Mahabub Hossain, "Infrastructure and Development of a Rural Economy," International Food Policy Research Institute, Washington, D.C., 1987 (mimeographed).

[30] The Bangladesh Institute of Development Studies survey of rural industrial enterprises estimated the annual rate of interest at 58 percent for loans supplied by local moneylenders and 48 percent for loans obtained from rich peasants. See Momtaz U. Ahmed, "Financing Rural Industries in Bangladesh," *The Bangladesh Development Studies* 12 (March-June, 1984): 59-79. The high rate of interest in informal markets is generally explained by the scarcity of capital, high costs of administering loan recovery, high risks of default, seasonal demand for credit, and in certain cases, a monopoly rent. See, among others, Anthony Bottomley, "Monopoly Profits as a Determinant of Interest Rates in Underdeveloped Rural Areas," *Oxford Economic Papers* 16 (November 1964): 431-437; and Millard Long, "Interest Rates and the Structure of Agricultural Credit Markets," *Oxford Economic Papers* 20 (July 1968): 275-288.

4

ORGANIZATION AND MANAGEMENT OF THE GRAMEEN BANK

Origin of the Bank

The Grameen Bank originated from a small action-research project undertaken in 1976 by a professor of economics in a village called Jobra, near Chittagong University. The project aimed to test the hypothesis that if financial resources are made available to the poor at reasonable terms and conditions, they can generate productive self-employment without external assistance. The professor had observed that a large proportion of the extremely poor households in the village were engaged in various nonfarm activities with a meager amount of capital borrowed from informal sources. The small size of the loans and the high rate of interest (10 percent a month) did not enable the poor to improve their living standard and accumulate capital of their own.

A local branch of a commercial bank was authorized to provide credit at an interest rate of 13 percent a year. When the professor approached this bank on behalf of the poor, the bank at first refused credit because of lack of collateral. After much persuasion, the bank agreed to provide loans to the poor, but the professor had to guarantee recovery. From this experience came the idea of the action research project and development of an appropriate mechanism for ensuring timely recovery of loans.

To convince the bankers that it was safe to extend credit to the poor without collateral, the professor proposed to the managing director of the agricultural development bank (BKB) that the professor be given the responsibility of operating a branch under the director's guidance. A suboffice of a branch was set up in March 1978 to allow the professor to experiment with his ideas about the appropriate mechanism for delivery of credit to the poor. This pilot experiment was successful, and with financial assistance from the Bangladesh Bank, the Grameen Bank Project was launched in June 1979 to see whether the experiment could be replicated in a wider area.[31] The project was located in Tangail District, far away from Chittagong University, and was tied in with local branches of the nationalized commercial banks and BKB. Within a year, 24 branches were set up—19 in Tangail District and 5 in Chittagong District. The project was further modified and developed through experiments. It ensured 98 percent recovery of loans at due date. But lack of enthusiasm from the participating banks constrained its further expansion. So a loan was arranged from IFAD, and the project was further extended to Dhaka, Rangpur, and Patuakhali districts. Between April 1982 and June 1983, 50 new branches were set up in these five districts.

A government ordinance in September 1983 transformed the project into the Grameen Bank, a specialized financial institution for the rural poor. The ordinance provided for an authorized capital of Tk 80 million[32] and paid-up share capital of Tk 30 million, and an ownership pattern of 60 percent with the government and 40 percent with the borrowers. By an amendment of the ordinance in July 1986, the paid-up share capital was raised to Tk 72 million, of which the Grameen Bank borrower-shareholders would subscribe to 75 percent and the government to 25 percent.

---

[31] The objectives behind the Grameen Bank Project are explained in Muhammad Yunus, *Grameen Bank Project in Bangladesh: A Poverty Focussed Rural Development Program* (Dhaka: Grameen Bank, 1982); and Muhammad Yunus, "Experiences in Organising Grass Root Initiatives and Mobilising People's Participation: The Case of G[illegible]en Bank Project in Bangladesh," paper presented at the 25th World Conference of the Society for Interna[illegible] Development, Baltimore, Md., 1982.

[32] At the 1986 official rate of exchange, U.S. $1.00 = Tk 30.00.

Organizational Structure

The managing director is the chief executive of the bank. The 1983 Grameen Bank ordinance stipulates a board of governors composed of the chairman, the managing director, and nine other members—five appointed by the government and four appointed by the borrower-shareholders. The 1986 amendment of the ordinance provides for 13 members of the board, of which 9 are to be selected from the borrower-shareholders. The board approves the policies of the bank and serves as the link between the bank, the Ministry of Finance, and other government organizations.

The branch office is the lowest administrative unit of the Grameen Bank and is considered the profit-responsibility unit. For accounting purposes, the bank charges 10 percent interest on the funds it lends to branch offices for disbursement to the borrowers at an annual interest rate of 16 percent. Hence a branch office is encouraged to keep its cost of operation at or below 6 percent of the amount of outstanding loans. The amount of profit earned is an important criterion for evaluating the performance of the branch staff. About 10 to 15 branch offices are supervised by an area office, which is usually located in a small town. The area manager is the final authority for approval of loans and supervises loan utilization and recovery with the help of a number of program officers. The area offices are accountable to the zone office located in the district headquarters. The zone manager is responsible for handling accounts and managing funds. Recently the zone office has also taken responsibility for monitoring, evaluating, and supervising the social development programs. A zone manager works in close contact with the area managers, who attend management meetings once or twice a month in the zone office.

The head office, located in Dhaka, basically maintains liaison with the government and provides feedback to lower-level offices. It is also responsible for supervising the training of bank staff and for research and development activities.

Initially there were only the head office and the branch offices. With the increase in the number of branch offices and expansion of the bank in a number of districts, the zone offices were created. Area offices were created when the number of branch offices grew beyond the capacity of a zone office to supervise. As the number of branches increases, the zone grows horizontally, and when it reaches a critical size a new zone is created.

With rapid expansion of the bank, management functions and decisionmaking powers are gradually delegated to lower levels. Most of the functions of the head office were assigned to zone offices when they were established. The zone offices delegated to area offices the power of account supervision and loan approval. Social development programs were initially located at the head office, but authority for these was soon transferred to zone offices, and zone offices are now planning to transfer responsibility for these programs to area offices. In this process of horizontal growth and decentralization of power, the head office becomes a secretariat or information clearinghouse. Ultimately it retains functions such as monitoring and evaluation, research and development, supervision of training, and similar activities that benefit from access to information from different operational areas.[33]

---

[33] For an excellent account of the organizational development and the functions of the bank, see Andreas Fugelsang and Dale Chandler, *Participation As Process—What We Can Learn from Grameen Bank, Bangladesh* (Oslo: Norwegian Ministry of International Development, 1987). This section draws heavily from the report.

Formulation and change of policies are arrived at by a consensual approach through meetings of the managing director with the heads of various departments located in the head office and with zone managers. The managing director meets with the zone managers twice a year to exchange experiences and discuss issues for further development of the bank. The meetings may continue for up to three days. The branch managers are encouraged to try their own ideas in the field, and if successful, to pass them on to higher levels for testing and development and ultimately for replication in other areas. Innovative ideas are also taken from the borrowers when their representatives attend workshops for an exchange of views among themselves and with higher bank officials. A substantial part of the managing director's time is spent traveling in the field to maintain contact with borrowers and with staff of the branch offices.

Mode of Operation

The Grameen Bank now follows standard operational procedures that evolved throughout the 1976-83 period in a process of continuous interaction with the poor. A Grameen Bank branch normally covers an area of about 15 to 20 villages located in a union, or at most two unions, in the vicinity of the branch. The branch is headed by a branch manager and includes six bank workers, an accountant, and one or two bank assistants. A person from a household that owns less than 0.5 acre of cultivated land, or assets with a value equivalent to less than 1.0 acre of medium-quality land, is eligible to receive a loan. (The original project eligibility limit of 0.4 acre of cultivated land was revised upward by the Grameen Bank Ordinance of 1983.) Because most members of the target group are illiterate and are shy about coming to banks, the banking services are brought to their doorsteps. The size of the branch and the area covered is determined by the bank workers' daily travel to maintain contact with the target group. In most cases, because of underdeveloped roads and transport facilities, the bank workers have to walk.

When the Grameen Bank decides to open a branch, the first task of the branch manager is to prepare a socioeconomic report covering the geography, economy, demography, transport and communication infrastructure, and political power structure of the area to be covered by the branch. The bank manager thus becomes acquainted with the locality and the people before starting operation. When the report is approved by the head office, the manager arranges a general public information meeting, inviting all classes of people in the locality. At the meeting the manager introduces bank officials and explains the Grameen Bank's purpose, rules, and programs. The local elites realize that the initiative is for the benefit of the poor only, and the poor understand that in order to receive loans they will have to organize themselves in groups and associations and interact with each other. The bank's operation starts after the meeting.

Interested persons are asked to form groups of five like-minded people of similar economic standing who enjoy mutual trust and confidence. The bank has settled on a group of five through trial and error. Initially, loans were given to individuals, but that quickly proved to be uncontrollable for the staff. Then groups of 10 or more were organized and the idea of mutual responsibility was introduced, but that size turned out to be too large to have the informal relationship among members that is necessary for mutual responsibility to be effective. In the end, five members proved to be the most practical size.[34]

Only one person from a household can be a member,[35] and relatives must not be in the same group. Male and female members form separate groups. Each group elects a chairperson and a secretary, and these positions rotate among members on a yearly basis so that all members have the learning experience that accompanies the responsibilities of these positions. The chairperson is responsible for discipline in the group and for supervision of loan utilization by the members. Members conduct business with a bank worker, through the chairperson, at weekly meetings that all members are obliged to attend.

---

[34] Ibid., p. 57.

[35] Initially, a number of persons from the same household could receive loans from the bank, provided they belonged to different groups. But in 1982 the policy was changed in view of the experience that such households faced difficulty in effective utilization of the loans and repayment of installments. The present policy is to provide a loan to only one member of a household, and preferably to a female member.

A number of groups from the same village are federated into a center and the weekly meetings are held at the center level. Again, groups of male and female members form separate centers. The group chairpersons elect a center chief and a deputy center chief, who hold office for one year only. Center chiefs ensure attendance at the weekly meetings, payment of loan installments, and overall discipline, and conduct the program of the meetings. The bank worker attends the center meetings, and all bank business is conducted openly in the meeting in front of the members.

Loans are given to individuals (for a maximum of Tk 5,000) without any collateral. A borrower may use the credit in any productive activity, but the loan has to be used immediately and the principal repaid in 50 weekly installments.

Disbursement of loans is not a simple matter. When a group is formed, it is kept under close observation for a month by the bank worker to see if members are conforming to the discipline of the Grameen Bank. The prospective borrowers are obliged to participate in a group training program for a minimum of seven days of continuous instruction by the bank worker. The training is intended to make the members thoroughly conversant with the rules and regulations of the bank. This includes understanding the purpose of the various bank procedures; the responsibilities of the group chairperson and the center chief; the group savings program; health, children's education, and other social development programs; and learning to make signatures. The group is accorded formal recognition when all members are found to be well versed in the rules and procedures. Two members of the group then receive loans and their loan-repayment behavior is observed for a month or two. If they pay the weekly installments on a regular basis, the next two members become eligible for loans. The group chairperson is the last member to receive a loan. A repeat loan is not approved for any member until the accounts of all members of the group are settled.

The group functions as an institution to ensure mutual accountability. The individual is kept in line by a considerable amount of pressure from other members of the group. The existence of the group thus acts as the collateral for the bank loans. The credibility of the group as a whole and its future benefits in terms of new loans are in jeopardy if one member breaks the discipline and defaults on loan repayments. So groups sometimes decide to fine or to expel a member who fails to attend a meeting and willfully defaults on payment of installments. Other members of the group also extend financial support to a member in times of genuine difficulty when the member cannot pay the installment. A member may leave the group when the loan is fully repaid; if a member leaves earlier, the responsibility for paying the balance falls to the remaining group members. When an entire group defaults, the responsibility of repayment falls to the center.

One of the regulations of the Grameen Bank is that each member must save one taka every week besides 5 percent of the loan amount, which is kept aside at the time of disbursement. The savings are accumulated in the Group Fund. This account is managed by the group on a consensual basis, thus providing the members with an essential experience in the collective management of finances. A member who leaves a group is entitled to withdraw the personal weekly savings accumulated in the fund, but cannot reclaim the 5 percent deducted from the loans. When forming a group, all members sign an agreement to that effect. The amount collected from fines imposed on members for breach of discipline is also accumulated in the Group Fund for the benefit of all members. This amount is deposited with Grameen Bank at 8.5 percent annual interest.

A member can borrow from the Group Fund for consumption at times of sickness or social ceremony, so that it is not necessary to take these expenses out of capital or go back to the informal markets for such loans. Group Fund loans for investment are also allowed if all members of the group agree. The group decides the terms and conditions of these loans, which are normally granted interest-free.

It is often argued that the poor value credit from informal sources more highly than from financial institutions because they perceive the informal lender as a permanent and reliable source available to finance consumption as well as production expenses.[36] By creating the Group Fund, the Grameen Bank has ensured the same flexibility in its credit services as in the informal markets.

Each borrower is also obliged to pay a sum equivalent to 25 percent of the amount charged by the bank as interest. This amount is accumulated in the Emergency Fund created for insurance coverage in case of default, death, disability, or other unforeseen events. This fund is managed by members at the center level and requires the joint signatures of the center chief, deputy center chief, and bank manager for its operation. On behalf of a member, the group can claim from the Emergency Fund up to Tk 2,500, or 50 percent of the amount accumulated by the member, whichever is less. The disbursements from the Emergency Fund have so far been negligible. The bank is studying various plans for effective utilization of the fund.

Beginning in 1984, a social development program called "Sixteen Decisions" was introduced by the bank to imbue members with discipline, unity, and hard work and to improve their living standard. These decisions include certain codes of conduct that members are encouraged to follow in their daily life, such as production of fruits and vegetables in kitchen gardens, investment for improvement of housing and education of children, use of latrines and safe drinking water for better health, and rejection of dowry in marriages (see Figure 2). Physical training and parades are held in weekly center meetings for both men and women, and the "Sixteen Decisions" are chanted as slogans. The bank management says that observance of these decisions—including participation in physical training and parades—is not compulsory, but in the field their observance has become a requirement for receiving a loan.

With the introduction of "Sixteen Decisions," the Grameen Bank has moved into an overall development program for the poor. Credit has been an entry point and now serves as a catalyst in the development process. The managing director, however, emphasizes the bank's interest in the social development program. In the long run, better housing and sanitation, and increased consumption of vegetables and fruits improve the health of the borrower, increase his productivity and income, and hence ensure better recovery of loans. Development of kitchen gardens provides a regular source of income from which the borrower can partly finance the weekly installments. Dowry constitutes the greatest risk of default in repaying loans, as the poor borrower is under compulsion to use capital to finance it. The bank is working hard to do away with this social ill and the attendant economic burden on its members. Recently, children's education has been promoted through active help in establishing center schools, distributing textbooks, and setting up children's savings and funds, since basic skills in reading, writing, and arithmetic are required for increasing the productivity of labor.

---

[36] C. B. Baker, "Role of Credit in the Economic Development of Small Farm Agriculture," in U.S. Agency for International Development, *Small Farmer Credit: Analytical Papers,* vol. 19, SR 119 (Washington, D.C.: USAID, 1973), pp. 41-70.

Figure 2—The "Sixteen Decisions" program

Sixteen Decisions

1. The four principles of Grameen Bank—discipline, unity, courage, and hard work—we shall follow and advance in all walks of our lives.
2. We shall bring prosperity to our families.
3. We shall not live in dilapidated houses. We shall repair our houses and work towards constructing new houses as soon as possible.
4. We shall grow vegetables all the year round. We shall eat plenty of them and sell the surplus.
5. During the planting seasons, we shall plant as many seedlings as possible.
6. We shall plan to keep our families small. We shall minimize our expenditures. We shall look after our health.
7. We shall educate our children and ensure that they can earn enough to pay for their education.
8. We shall always keep our children and the environment clean.
9. We shall build and use pit latrines.
10. We shall drink tubewell water. If it is not available, we shall boil water or use alum.
11. We shall not take any dowry in our sons' weddings, neither shall we give any dowry in our daughters' weddings. We shall keep the center free from the curse of dowry. We shall not practice child marriage.
12. We shall not inflict any injustice on anyone, neither shall we allow anyone to do so.
13. For higher income we shall collectively undertake bigger investments.
14. We shall always be ready to help each other. If anyone is in difficulty, we shall all help.
15. If we come to know of any breach of discipline in any center, we shall all go there and help restore discipline.
16. We shall introduce physical exercise in all our centers. We shall take part in all social activities collectively.

Source: Kamal Siddiqui, *An Evaluation of the Grameen Bank Operation* (Dhaka: National Institute of Local Government, 1984).

Note: Formulated in a National Workshop of 100 female center chiefs in March 1984, "Sixteen Decisions" might be called the social development constitution of Grameen Bank. All Grameen Bank members are expected to carry out these decisions.

Loan Approval and Supervision of Loan Utilization

Investment alternatives are discussed by members of a group in the weekly center meetings. When the group members and the bank worker are convinced of the viability of a potential loan, the center chief initiates the loan approval process by filling in a loan proposal form, signing it, and giving it to the bank worker, who makes a recommendation on the loan and passes it to the branch manager with the proposal form. After consulting with colleagues about a number of loan proposals and checking the viability of the loan amounts through field visits if necessary, the branch manager consolidates the individual loan proposals into a single proposal and submits it, along with the individual proposals, to the program officer in the area office. On the recommendation of the program officer, the area manager gives the final authorization necessary for releasing a loan, which is then disbursed by the bank worker in the center meeting. The whole process normally takes about one to two weeks from group discussion of an individual loan proposal to disbursement of the loan. The borrower does not have to deal with the bank staff for the loan, as would be required in other banks.

Once a loan is approved, the branch manager issues the money along with a loan passbook. The loan is given for one year and is to be repaid in 50 equal weekly installments of 2 percent of the loan amount. The 50 installments cover repayment of the principal. The interest on the loan and the contribution to the Emergency Fund are collected in the remaining two weeks of the year. The bank worker collects the weekly installment in center meetings, which take place early in the morning on a fixed day each week, and records the installment in the loan passbook of the member. The rate of interest on the loan is 16 percent a year—the same rate charged for agricultural loans by other banks in the country. The interest payment, however, comes to 8.12 percent of the loan, since the repayment is amortized over 50 weeks.

It is a regulation of the Grameen Bank that a borrower must invest the money within seven days of receipt for the purpose specified in the loan proposal. The procedure for monitoring the loan utilization starts with the group chairperson, who signs a loan utilization form and forwards it to the center chief. The center chief passes the form to the bank worker, who checks on the utilization of the loan and provides a written description of the type of investment. The bank worker sends the form, along with the description, to the branch manager, who is responsible for personally checking 50 percent of the cases at random. Once satisfied through field visits, the branch manager signs the form and forwards it to the program officer, who is the ultimate authority for supervision of loan utilization. If a loan cannot be used immediately, the borrower is advised to give the money back to the branch office and claim it when ready. In this way the borrower can avoid weekly installments and interest on the loan while it is idle.

Thus, recovery of loans is ensured by tight supervision of loan utilization by the bank staff and by mutual responsibility in the group and the center. In the event of default, there is no collateral that the bank can resort to and there is a high risk that the loan will become a bad debt. But this does not happen in practice, because a potential defaulter is singled out at the very beginning by fellow members of the group. If, because of unusual circumstances, a member fails to pay the installments, fellow members will usually contribute the money, while making it a private matter to collect from the defaulting member. Such group behavior is also facilitated by the regulation that in case of default by a member, the group will be ineligible for repeat loans.

Training and Workshops

An important factor behind the success of the Grameen Bank is its intensive field-oriented training of bank staff. Branch managers and bank workers are directly recruited, the former from recent university graduates and the latter from intermediate college graduates (12 years of schooling). The personnel at higher levels are mostly promoted from among the branch managers on the basis of performance and experience. Most officials in the area, zone, and head offices have been previously trained in, and have worked in, rural areas for a long time before taking their present positions. Thus, branch managers and bank workers are Grameen Bank's target groups for training.

One training course for branch managers lasts for about six months, of which only three weeks are spent in classroom courses at the training institute in the head office. The training begins with a two-day overview course in which the trainer introduces various banking forms that the trainee will have to master. The trainee is then sent to the field and attached to a branch office for 24 weeks, in three periods of 8 weeks. After both the first and second field visits, one week is spent in classroom courses at the training institute.

The objective of the training is to provide the trainee with (1) an understanding of the social and economic milieu and the constraints within which the Grameen Bank has to operate; (2) the capacity to identify the target clientele group, organize and motivate them, and prepare them to receive the bank's services; (3) an understanding of how to process loan applications and assist center chiefs in conducting meetings, collecting various dues, and preparing source vouchers for bank accounts; and (4) the ability to manage branch administration and accounts and to supervise loan recovery. The curriculum consists of 50 topics, including group and center organization, operation of the group and loan funds, loan-processing procedures, deposit-banking, accounts maintenance, record keeping, branch accounting, fund management, group dynamics, and maintenance of various forms, ledgers, and registers.[37]

During the first eight weeks in the field, each trainee must prepare detailed case studies of two borrowers, describing the life history of each and how their lives have changed as a result of intervention by the bank. Information about the wage rate, seasonal pattern of labor demand, terms and conditions of tenancy and the informal credit market, and prices of essential commodities for the locality is also collected. In the course of this exercise the trainee becomes acquainted with the magnitude of poverty in the area, grows to understand the process that generates it, and finds the rationale for and importance of a bank worker's task. After completion of this phase, the trainee returns to class at the training institute for a week. The class usually comprises 30 trainees drawn from 30 branches throughout all five zones. The main emphasis in the class is on discussing and questioning each other's experiences in their various fields of operation. For subsequent phases of field training, tasks are assigned to facilitate understanding of group dynamics, branch operations, and supervision and management of loan utilization and recovery. By the end of the training period, each trainee must have visited at least 15 centers and have followed up the loan utilization of two to three borrowers in each of the centers. After successful completion of training, appointments are confirmed and each new staff member is assigned to a different branch. Often new staff will have to open a branch on their own. Before departing for their new posts, new branch managers are advised by their trainers to build a branch better than the one in which they were trained.

It is apparent from the above discussion that the branch office takes substantial responsibility for training staff. Branch managers are considered responsible for producing good trainees. Part of their duty is to see that the trainees complete their assignments. If the trainees perform poorly, the branch manager is held responsible—and this is one of the factors taken into consideration for promotion of branch managers. The managers who are best able to assist and motivate the trainees are chosen for promotion as trainers. This promotion system shows the priority that the Grameen Bank attaches to the education of its personnel.

---

[37] Grameen Bank, "Annual Progress Report: 1986." Grameen Bank, Dhaka, 1987 (mimeographed).

Such intensive training helps to build a dedicated cadre of bank employees. New recruits who find the Grameen Bank work difficult and not suited to their life-style leave the bank during training. Nearly a quarter of the staff drop out at this stage, but the dropout rate after final posting is insignificant.

In 1986 the training program accounted for one-fifth of the bank's operating expenses (excluding the cost of loan funds). A total of 2,118 officers and staff (7 per existing branch) were inducted for training; 26 percent dropped out, 33 percent were carried over for further training in the next course, and the remaining 41 percent were assigned final posting.

The Grameen Bank also organizes a number of workshops and exchange visits for borrowers, center chiefs, and bank staff to disseminate new ideas and experiences. In the workshops, participants discuss various problem-solving devices and approaches and build up amity and cooperation among themselves. During 1986, 334 workshops were organized and these were attended by 10,484 persons, 79 percent of whom were borrowers and center chiefs. The major responsibility for planning and implementation of workshops is carried out by the zone, area, or branch offices, according to the type of workshop.

A national workshop for women borrowers is held every two years and is attended by the managing director and the senior officers of the Grameen Bank. Fourteen women borrowers, two social development officers, and three bank workers from each zone are selected to participate in the workshop.[38] The workshop lasts for four to five days, during which experiences in various social development programs are discussed and modifications suggested. The current "Sixteen Decisions" program is an outcome of the national workshop held in 1984.

---

[38] Fugelsang and Chandler, *Participation As Process,* p. 129.

5

PROGRESS OF BANK OPERATIONS

Expansion of Coverage

When the Grameen Bank began its operation as a specialized financial institution in October 1983, it had 75 branches in 5 of the 21 old districts of Bangladesh. The bank continues to operate only in those five districts but has vastly expanded its coverage. By the end of February 1987 it had 298 branches. The Bangladesh Krishi Bank, the agricultural development bank established in the early 1960s to provide agricultural credit, had 992 branches covering the entire country at the end of 1986.

The districts covered by the Grameen Bank constitute 25 percent of the area, 27 percent of the rural households, and 30 percent of the population of Bangladesh. These districts are similar to the rest of the country in population pressure, landlessness, and agricultural productivity and growth. For example, in 1983/84, the proportion of Grameen Bank target-group households was 49 percent in these districts, compared with 45 percent for Bangladesh; the proportion of cultivated area irrigated was 22 percent, compared with 20 percent for Bangladesh; and the annual growth rate of crop output during 1976-85 was 3.0 percent, compared with 2.9 percent for Bangladesh (Table 4).

The presence of the Grameen Bank is conspicuous in the five districts of its operation (see Table 5). It has covered more than 29 percent of the villages in these districts, varying from 19 percent in Dhaka to 55 percent in Patuakhali. It has organized nearly 250,000 households in 11,000 centers. In the districts of Patuakhali and Tangail, it has covered more than 25 percent of the target group (households holding less than 0.5 acre of land), and throughout all five districts, about 13 percent of the target group. This compares favorably with the estimate that only 14 percent of rural households received credit from all institutional sources during 1982 (Table 3). In the coun-

Table 4—Selected characteristics of the districts covered by the Grameen Bank

District	Population per Square Kilometer, 1981	Land Owned per Household, 1983/84	Land Operated per Farm,[a] 1983/84	Share of Landless Households,[b] 1983/84	Growth Rate of Crop Output, 1976-85	Share of Cultivated Area Irrigated, 1983/84
		(acres)	(acres)		(percent)	
Chittagong	760	0.99	1.93	58.1	2.5	37.1
Tangail	743	1.63	2.22	40.2	4.8	31.2
Dhaka	1,384	1.19	1.80	52.4	2.3	23.7
Rangpur	700	1.65	2.52	44.1	3.4	19.8
Patuakhali	463	1.98	3.36	47.1	1.8	2.1
All Grameen Bank districts	848	1.41	2.37	49.3	3.0	22.4
Bangladesh	624	1.63	2.59	44.8	2.9	19.9

Sources: Compiled from Bangladesh, Bureau of Statistics, *Final Report of Bangladesh Population Census, 1981: Analytical Findings and National Tables* (Dhaka: Government Press, 1984); Bangladesh, Bureau of Statistics, *The Bangladesh Census of Agriculture and Livestock: 1983-84*, vol. 1 (Dhaka: Government Press, 1986); and Bangladesh, Bureau of Statistics, *1986 Statistical Yearbook of Bangladesh* (Dhaka: Government Press, 1986).

[a] Excludes households operating less than 0.5 acre.

[b] Includes households operating less than 0.5 acre.

Table 5—Coverage of the Grameen Bank, February 1987

District	Number of Branches Under Operation	Number of Villages Covered	Share of Villages Covered	Number of Centers Organized	Number of Members Enlisted		Share of Target Group Households Covered[a]
					Male	Female	
			(percent)				(percent)
Chittagong	52	749	39.1	1,918	10,307	31,887	9.3
Tangail	57	1,201	48.6	2,139	16,440	29,926	27.6
Rangpur	72	1,322	24.1	2,635	16,786	45,524	11.7
Dhaka	72	1,422	18.9	2,444	12,185	41,198	8.2
Patuakhali	45	758	54.5	1,698	4,813	37,892	29.2
Bangladesh	298	5,452	6.4	10,834	60,531	186,427	4.0

Sources: Grameen Bank, *Consolidated Cumulative Statement as of February 28, 1987* (Dhaka: Grameen Bank, 1987); and Bangladesh, Bureau of Statistics, *The Bangladesh Census of Agriculture and Livestock: 1983-84,* vol. 1 (Dhaka: Government Press, 1986).

[a] Estimated from the number of households operating less than 0.5 acre, reported in the 1983-84 agricultural census. It is assumed that the number of households in this category grew at 2.0 percent a year.

try as a whole, the Grameen Bank has reached more than 6 percent of the villages and 4 percent of the target-group households (Table 5).

The progress in disbursement of credit, recovery of loans, and savings in the Group Fund and Emergency Fund is seen in Table 6. By the end of 1986, Tk 1,470 million had been disbursed, of which Tk 1,169 million had already been recovered. The amount disbursed each year increased from Tk 99 million in 1983 to Tk 542 million in 1986. Over the last three years, the amount disbursed increased by an average of 33 percent a year. The disbursement is now financed largely with the revolving fund, that is, the amount recovered from the borrowers. The amount recovered from them increased from Tk 59 million in 1983 to Tk 466 million in 1986. The additional disbursement over recovery in 1986 was Tk 76 million, which is only 16 percent of the total amount recovered in that year, compared with 68 percent in 1983 and 52 percent in 1984.

Table 6—Trends in disbursement and recovery of loans and accumulation in Group Fund and Emergency Fund, 1979-86

Activities	1979-82	1983	1984	1985	1986
			(thousand persons)		
Members enlisted	30	28	63	51	63
Total members[a]	30	58	121	172	235
			(Tk million)		
Amount of credit disbursed	96.0	99.0	304.0	429.0	542.0
Amount of credit recovered	64.0	59.0	200.0	380.0	466.0
Additional disbursement over recovery	32.0	40.0	104.0	49.0	76.0
Cumulative amount disbursed[a]	96.0	195.0	499.0	928.0	1,470.0
Cumulative amount recovered[a]	64.0	123.0	323.0	703.0	1,169.0
Outstanding loans[a]	32.0	72.0	176.0	225.0	301.0
Cumulative savings in Group Fund[a]	8.1	15.9	37.9	71.4	114.5
Cumulative savings in Emergency Fund[a]	1.5	3.4	6.3	12.7	22.3

Sources: Grameen Bank, *Annual Report, 1985* (Dhaka: Grameen Bank, 1986); and Grameen Bank, *Consolidated Cumulative Statement as of December 31, 1986* (Dhaka: Grameen Bank, 1987).

[a] The figures are for the end of the calendar year.

The size of the bank's business is indicated by the total amount of outstanding loans with borrowers (the interest is charged on this amount). This total increased from Tk 72 million at the end of 1983 to Tk 301 million at the end of 1986, a rate of increase of 62 percent a year.

The amount accumulated in the Group Fund swelled from Tk 16 million at the end of 1983 to Tk 115 million by the end of 1986. The amount of savings per member was Tk 487, which is about 11 percent of the average per capita income for the country in 1985/86. In Tangail District, where most of the old branches are located, average savings per member at the end of 1986 stood at Tk 720—about 16 percent of the per capita income. By the end of 1986, the amount of savings in the Group Fund was 38 percent of the amount outstanding with the borrowers.

The Group Fund is constituted by a 5 percent compulsory deduction from each loan and a Tk 1.00 weekly contribution by each member. By the end of 1986, the Grameen Bank had disbursed a cumulative amount of Tk 1,470 million, so the compulsory (nonrefundable) deduction amounted to Tk 73.5 million. The borrowers' own savings in the Group Fund totaled 41 million, which they are entitled to withdraw when they leave the group. This part of the savings is equivalent to about 13.6 percent of the amount of outstanding loans.

The accumulation in the Emergency Fund also increased rapidly during 1983-86, from Tk 3.4 million to Tk 22 million. This fund is constituted by an additional contribution from each member of 25 percent of the interest charged on the loan, which comes to about 8 percent of the principal. Thus 2 percent of the amount recovered is deposited to the fund if the bank succeeds in collecting the interest due on the loan. By the end of 1986, Tk 1,169 million had been recovered from the borrowers, which meant that Tk 23.4 million was due to be deposited in the Emergency Fund. The accumulation in the fund was about 95 percent of this amount, and more than 7.4 percent of the loans outstanding with the borrowers, which shows the strength of the Grameen Bank in handling potential situations of bad debt.

An important characteristic of the bank is its rapidly expanding coverage of women. In Bangladesh, women generally do not participate in economic activities outside the home. A 1983/84 labor force survey estimated that only 9 percent of the labor force in Bangladesh were women.[39] But a large proportion of women, particularly in the lower-income groups, engage in various expenditure-saving activities within the household, such as food processing, kitchen gardening, goat and poultry raising, and manufacturing of various household needs (for example, quilts, rope, and nets). Women are attracted to the Grameen Bank because, with credit, they can extend the scale of such activities and turn them into income-earning activities for the household. The bank management argues that women borrowers are more careful with the capital and are more disciplined; hence the bank prefers to give credit to a female rather than a male worker in the household.[40]

Although less than 10 percent of the women in Bangladesh participate in the labor force, by as early as 1980, 39 percent of the Grameen Bank Project members were women. The coverage of women increased rapidly after the bank started operating as a specialized institution (see Table 7). By the end of 1986, about 75 percent of Grameen Bank members were women and they had 69 percent of the outstanding loans. In Patuakhali district, women were 89 percent of total members by February 1987 (Table 5).

Table 7 shows that the bank currently mobilizes mostly women members. Out of 62,751 new members enlisted during 1986,

---

[39] Bangladesh, *Labor Force Survey, 1983-84.*

[40] For a detailed study of women's participation in the rural labor market, see Rushidan Islam Rahman, *The Wage Employment Market for Rural Women in Bangladesh,* Research Monograph 6 (Dhaka: Bangladesh Institute of Development Studies, 1986).

Table 7—Trends in membership and borrowing, by sex of borrower, 1983-86

	Members Enlisted[a]			Amount of Outstanding Loans with Members		
Year	Male	Female	Female as Share of Total	Male	Female	Female as Share of Total
	(thousands)		(percent)	(Tk million)		(percent)
1983	32	26	45	44	28	39
1984	53	68	56	89	88	50
1985	59	113	66	91	134	60
1986	61	174	74	92	209	69

Sources: Grameen Bank, *Annual Report,* 1984, 1985 (Dhaka: Grameen Bank, 1985, 1986); and Grameen Bank, *Consolidated Cumulative Statement as of December 31, 1986* (Dhaka: Grameen Bank, 1987).

[a] The figures are cumulative.

61,523 (98 percent) were women. In the same year, the bank disbursed Tk 542 million, of which female borrowers received 72 percent. The total of outstanding loans with borrowers at the end of 1986 increased by Tk 76 million over the total amount at the end of 1985; the increase for female borrowers was Tk 75 million. Thus the Grameen Bank has turned into a bank for rural poor women.

Loan Portfolio

The annual reports of the Grameen Bank list more than 300 activities for which credit is extended.[41] These activities can be grouped under five broad sectors: crop farming and forestry, livestock and fisheries, processing and manufacturing, trading and shopkeeping, and transport and other services. Since 1982, credit has also been extended to groups consisting of a number of members for collective enterprises such as the purchase of shallow tubewells, power pumps, rice hullers, and oil mills and leasing of land, ponds, and markets.

The share of different sectors in total loans disbursed up to 1986 is shown in Table 8. The important point to note is that the bank basically finances noncrop agricultural and nonfarm activities. Crop cultivation and forestry accounted for only 2.2 percent of the loans disbursed in 1986, though the share of this sector has increased over time. As discussed below, most of the loans disbursed under collective enterprises are taken for crop cultivation, and a part of the loans taken for other activities is also diverted to crop cultivation. Even after accounting for these, the share of Grameen

Table 8—Trends in disbursement of loans, by sector, 1979-86

Sector	1979-83	1984	1985	1986
	(percent of total loans)			
Crop cultivation and forestry	1.5	1.6	2.2	2.2
Livestock, poultry raising, and fisheries	24.7	30.6	36.9	45.7
Processing and manufacturing	25.2	22.2	24.6	25.0
Trading and shopkeeping	39.7	32.9	28.1	23.1
Transport operations and other services	7.0	4.5	3.2	2.6
Collective enterprises	1.9	8.2	5.1	1.4

Sources: Grameen Bank, *Annual Report,* various issues (Dhaka: Grameen Bank, various years); and Grameen Bank, "Annual Progress Report, 1986," Dhaka, Grameen Bank, 1987 (mimeographed).

---

[41] Grameen Bank, *Annual Report,* various issues (Dhaka: Grameen Bank, various years).

Table 9—Disbursement of loans to male borrowers, by sector, 1979-86

Sector	1979-83		1984		1985		1986	
	Amount of Loans	Share of Loans	Amount of Loans	Share of Loans	Amount of Loans	Share of Loans	Amount of Loans	Share of Loans
	(Tk million)	(percent)	(Tk million)	(percent)	(Tk million)	(percent)	(Tk million)	(percent)
Crop cultivation and forestry	2.32	1.8	3.06	2.0	4.48	2.7	4.55	3.0
Livestock, poultry raising, and fisheries	19.76	15.4	25.32	16.6	33.09	20.0	32.70	21.8
Processing and manufacturing	21.39	16.7	19.35	12.7	21.46	13.0	20.59	13.8
Trading and shopkeeping	67.95	52.9	76.15	50.1	82.85	50.1	77.64	51.9
Transport operations and other services	13.49	10.5	12.63	8.3	11.85	7.2	11.29	7.5
Collective enterprises	3.49	2.7	15.63	10.3	11.75	7.1	2.94	2.0
All sectors	128.40	100.0	152.14	100.0	165.48	100.0[a]	149.71	100.0

Sources: Grameen Bank, *Annual Report,* 1984, 1985, 1986 (Dhaka: Grameen Bank, 1985, 1986, 1987).

[a] Parts do not add to total because of rounding.

Bank loans for crop cultivation has never been more than 6 percent.

In the initial years, trading and shopkeeping received the largest proportion of loans. With the expansion of the bank, however, the share of this sector has been reduced drastically—from about 40 percent during 1979-83 to 23 percent in 1986. The absolute amount of loans issued for trading and shopkeeping increased only marginally from Tk 120 million in 1985 to Tk 125 million in 1986, while total disbursement increased from Tk 429 million to Tk 542 million. The share of the livestock and fisheries sector increased rapidly from 25 percent during 1979-83 to 46 percent in 1986. The change is, however, mainly due to the expanding coverage of women, as women take a much smaller proportion of loans for trading and shopkeeping than do men. In 1986, 71 percent of the loans were issued for livestock raising and for rural processing and manufacturing activities.

The purpose for which the loan is taken differs significantly according to the sex of the borrower. Nearly half of the loans issued to men are disbursed for trading and shopkeeping activities, while a similar proportion of loans to female members is disbursed for livestock and poultry raising (see Tables 9 and 10). The share of different sectors in total loans disbursed to men and women has remained relatively stable over the years, except that the share for livestock has increased marginally at the expense of the processing and manufacturing sector. For all members, however, there has been a significant change in the sectoral shares of loans for livestock and fisheries at the expense of trading, and transport and other services (Table 8) because of the rapidly expanding coverage of female members. Women are little involved in trading and transport operations because those jobs have to be done outside the home. When women take loans for trading, they usually engage in shopkeeping within the household. Since the Grameen Bank is now concentrating its efforts on organizing poor women, nearly four-fifths of total loans in the future may go to the livestock and manufacturing sectors.

Individual activities that received more than 1 percent of the loans during 1983-85 are listed separately for male and female borrowers in Tables 11 and 12, respectively.

Table 10—Disbursement of loans to female borrowers, by sector, 1979-86

Sector	1979-83		1984		1985		1986	
	Amount of Loans	Share of Loans	Amount of Loans	Share of Loans	Amount of Loans	Share of Loans	Amount of Loans	Share of Loans
	(Tk million)	(percent)	(Tk million)	(percent)	(Tk million)	(percent)	(Tk million)	(percent)
Crop cultivation and forestry	0.63	1.0	1.90	1.2	4.87	1.9	7.35	1.9
Livestock, poultry raising, and fisheries	28.47	42.8	67.77	44.5	124.80	47.5	215.07	54.9
Processing and manufacturing	27.81	41.8	48.10	31.6	83.90	31.9	114.88	29.3
Trading and shopkeeping	9.39	14.1	23.94	15.7	37.41	14.2	47.22	12.0
Transport operations and other services	0.07	0.1	1.19	0.8	1.96	0.7	2.95	0.8
Collective enterprises	0.15	0.2	9.32	6.1	10.03	3.8	4.55	1.2
All sectors	66.52	100.0	152.22	100.0[a]	262.97	100.0	392.02	100.0[a]

Sources: Grameen Bank, *Annual Report,* 1984, 1985, 1986 (Dhaka: Grameen Bank, 1985, 1986, 1987).
[a] Parts do not add to total because of rounding.

The activities pursued by male members are diverse, particularly in the trading and processing sectors. The 20 major activities listed in Table 11 accounted for about 84 percent of the loans disbursed in 1985. The share of these 20 activities in total loans increased rapidly during 1983-85, indicating a gradual concentration of loans in the traditional activities. Four activities—cattle fattening, seasonal crop trading, milch cow raising, and paddy and rice trading—accounted for 39 percent of total loans issued in 1985, an increase from 29 percent in 1983.

The activities pursued with the Grameen Bank credit are less diverse for the female borrowers. The 14 activities listed in Table 12 accounted for 91 percent of total loans disbursed up to the end of 1985, but 3 activities—milch cow raising, paddy husking, and cattle fattening—accounted for 70 percent of total loans. Women also took a significant proportion of loans for traditional cottage industries such as handloom weaving, cane and bamboo works, mat making, fishing-net making, and tailoring.

In the initial years, the majority of loans issued by the Grameen Bank were for trading activities. This concentration attracted criticism from various circles. It was argued that excessive credit for this sector would be inflationary, since the circulation of the additional money would not be counterbalanced by an increase in production activity. Also, the larger volume of credit for trading, unless associated with a concomitant increase in production, would keep the volume of trade unchanged and would merely redistribute employment and income from nonmembers to members. It has been noted that the share of the trading sector in Grameen Bank loans had declined over time, but it still accounted for about 23 percent of total loans disbursed in 1986 (Table 8). In order to answer the criticism, some justifications for the trading sector loans are in order.

To examine the linkage of trade with the rural economy, trading activities were classified into a number of subsectors according to the origin of the commodity traded, and an estimate was made of the share of each subsector in total loans disbursed for trading and shopkeeping during 1980-85 (see Table 13). Trading was found to have a strong linkage with rural production activities such as crops, livestock, and fisheries,

Table 11—Major activities for which male borrowers took loans, 1983-85

Sector/Activity	Share of Total Loans Disbursed 1983	1984	1985
	(percent)		
Trading and shopkeeping			
Seasonal crop trading	5.1	8.5	10.5
Paddy and rice trading	9.0	10.3	8.4
Grocery and stationery shop	5.7	5.6	6.6
Cattle and goat trading	3.2	4.9	4.6
Handloom products trading	2.6	1.8	2.9
Cloth trading	1.7	1.8	2.9
Fish trading	2.2	2.1	2.3
Wood and timber trading	1.7	1.6	1.9
Peddling	2.1	1.7	1.9
Vegetable trading	1.2	1.6	1.5
Betel leaf and betel nut trading	0.8	1.0	1.4
Flour trading	1.7	1.7	1.2
Mustard seed trading	1.3	1.2	1.0
Gur (raw sugar) trading	1.1	1.2	0.9
Livestock and fisheries			
Cattle fattening	8.5	10.0	11.4
Milch cow raising	6.4	7.4	8.9
Processing and manufacturing			
Paddy husking	4.4	3.9	4.3
Handloom weaving	3.2	2.9	2.9
Transport and services			
Rickshaw pulling	5.8	5.9	5.3
Farming			
Crop cultivation	1.4	2.2	2.9
All major activities	69.1	77.3	83.7

Sources: Compiled from Grameen Bank, *Annual Report*, 1984, 1985 (Dhaka: Grameen Bank, 1985, 1986).

the trading of which received about 57 percent of trading sector loans. Trading of cottage industry products located in rural areas received another 8 percent of the loans. Among the major crops traded are paddy and seasonal agricultural produce such as pulses, oilseeds, and vegetables. Since these commodities face large seasonal fluctuations in price, some of the Grameen Bank loans may in fact be used for seasonal storage to take advantage of higher prices later. Widespread small-scale storage may have positive income distribution effects and may also improve the working of the rural commodity markets by reducing price fluctuations.

It should also be recognized that widespread petty trading may not necessarily replace large-scale trading in the organized sector. A major constraint for large-scale traders to move into interior areas is the high unit cost of transport due to underdeveloped infrastructure facilities.[42] The advantage of the petty traders is that the small amounts they trade can be carried as headloads. The environment of underdeveloped trading and transport sectors induces rural households in interior areas to engage more in subsistence-oriented production. Provision of credit for petty trading may thus induce production for the market and in-

Table 12—Major activities for which female borrowers took loans, 1983-85

Sector/Activity	Share of Total Loans Disbursed 1983	1984	1985
	(percent)		
Trading and shopkeeping			
Paddy and rice trading	3.7	3.7	3.7
Grocery and stationery shops	4.3	4.0	3.7
Peddling	0.7	1.1	1.2
Flour trading	1.8	1.5	1.2
Livestock and fisheries			
Milch cow raising	29.1	33.1	36.3
Cattle fattening	11.0	12.3	10.9
Goat and poultry raising	2.9	1.9	2.0
Processing and manufacturing			
Paddy husking	23.3	25.0	22.6
Cane and bamboo works	3.1	2.0	2.5
Handloom weaving	3.5	1.8	1.8
Mat making	1.4	1.6	1.8
Cheera and muri (rice products)	2.3	1.9	1.3
Tailoring	1.8	1.2	1.2
Fishing-net making	0.8	1.2	1.0
All major activities	89.7	92.3	91.2

Sources: Compiled from Grameen Bank, *Annual Report*, 1984, 1985 (Dhaka: Grameen Bank, 1985, 1986).

---

[42] The unit cost of transport for bullock carts that operate on dirt roads in interior areas is about seven times higher than the cost for trucks that operate on paved roads. The average unit cost of transport for all traffic is estimated at 2.3 times higher on a dirt road than on a paved road in the same locality. See Omar H. Chowdhury and Mahabub Hossain, "Roads and Development: A Case Study of Return on Investment in Rural Roads in Bangladesh," Bangladesh Unnayan Parishad, Dhaka, December 1985 (mimeographed).

Table 13—Distribution of trading sector loans, by origin of commodities, 1979-85

Sectoral Origin of Commodities	1979-83 Amount of Loans	1979-83 Share of Loans	1984 Amount of Loans	1984 Share of Loans	1985 Amount of Loans	1985 Share of Loans
	(Tk 1,000)	(percent)	(Tk 1,000)	(percent)	(Tk 1,000)	(percent)
Crop cultivation	28,590	37.0	46,392	46.4	54,886	45.6
Livestock, poultry raising, and fisheries	12,479	16.1	13,240	13.3	13,514	11.2
Forestry	2,519	3.3	3,130	3.1	3,865	3.2
Agricultural inputs	886	1.1	567	0.6	612	0.5
Rural industry	8,712	11.3	10,284	10.3	9,770	8.1
Urban industry	9,524	12.3	7,347	7.3	11,399	9.5
Trading	62,710	81.1	80,960	80.9	94,046	78.2
Peddling	3,553	4.6	3,863	3.9	5,886	4.9
Shopkeeping	11,087	14.3	15,260	15.2	20,365	16.9
Total	77,350	100.0	100,083	100.0	120,297	100.0

Sources: Constructed from Grameen Bank, *Annual Report,* 1984, 1985 (Dhaka: Grameen Bank, 1985, 1986).

crease the volume of trade. Petty traders would operate in interior areas and carry goods to secondary markets well connected by roads, rail, or waterways, from where the business would be taken over by large traders. In this sense, provision of credit for petty trading can facilitate the development of markets and thereby increase the volume of both local production and trade.

Of course, the demand for trade services will increase over time because of the linkage effects of agricultural growth and rapid movement of rural population to urban areas (discussed in Chapter 3 in the context of the role of institutional credit in alleviation of poverty). Gradual diffusion of new technology in agriculture increases the labor productivity and household income of farmers and provides effective demand for a range of goods and services that are most effectively produced in rural areas by small-scale producers.[43] Grameen Bank loans for livestock raising and for processing and manufacturing activities are in fact supporting such activities. But the diffusion of technology also increases the demand for trading services to permit greater movement of both farm and nonfarm goods from producers to consumers. In order to allow the relatively poor people to gain from the dynamic process of development, access to working capital for trading is necessary. The bank's effort to provide the poor with access to credit for trading activities is thus highly desirable.

Collective Enterprises

In 1982 the Grameen Bank started providing large loans to a cooperative body consisting of a number of groups or centers for the joint undertaking of collective enterprises. A loan to an individual is limited to a maximum of Tk 5,000, but loans for collective enterprises are usually from Tk 50,000 to Tk 100,000. In a few cases, loans up to Tk 500,000 have been approved. The bank considers loans for collective enterprises to be one of its major areas of expansion for the benefit of the poor and for reducing the costs of operation.[44] The main objectives of these loans are to enable members to reap economies of scale in their activities, to

---

[43] John W. Mellor and Uma Lele, "Growth Linkages of the New Foodgrain Production Technologies," *Indian Journal of Agricultural Economics* 28 (January-March 1973): 35-55; and John W. Mellor, "Agriculture on the Road to Industrialization," in *Development Strategies Reconsidered,* ed. John P. Lewis and Valeriana Kallab (New Brunswick, N.J.: Transaction Books, 1986), pp. 67-89.

[44] Muhammad Yunus, *The First Decade of Grameen Bank, 1976-86* (in Bengali) (Dhaka: Grameen Bank, 1987).

Table 14—Loans disbursed for various types of collective enterprises, 1982-85

	1982-84		1985		1985 Loans as Share of Those in 1982-84
Type of Enterprise	Amount of Loans	Share of Loans	Amount of Loans	Share of Loans	
	(Tk 1,000)	(percent)	(Tk 1,000)	(percent)	
Improved technology	5,127	17.9	1,283	5.9	25.1
Leasing of markets and ferry crossings	3,495	12.2	1,323	6.1	37.9
Trading and storage	4,300	15.0	1,275	5.9	29.7
Joint farming	13,304	46.6	16,170	74.2	121.5
Livestock and fisheries	1,674	5.9	1,475	6.8	88.1
Transport operations and other services	680	2.4	255	1.2	37.5
Total	28,580	100.0	21,781	100.0[a]	76.2

Sources: Grameen Bank, *Annual Report*, 1984, 1985 (Dhaka: Grameen Bank, 1985, 1986).

[a] Parts do not add to total because of rounding.

compete with the upper-income group in activities that require large amounts of capital, and to increase labor productivity by adopting improved technology. Examples of such activities are investment in irrigation equipment; installation of rice, oil, and weaving mills; leasing of markets, orchards, waterbodies, and ferry crossings; and leasing of agricultural land. Loans are granted to groups and centers that have demonstrated that they are well managed, have observed the bank's rules and regulations meticulously, and have accumulated a substantial fund in a collective special savings account. Such a loan is issued to the collective body, but each member is responsible for an equal proportion of the loan and for making repayment in weekly installments of 2 percent of the loan amount, just as in the case of loans to individuals.

Collective enterprises are managed by three committees: one for management, one for audit, and one for finance.[45] On a consensual basis, the members select three representatives for each committee. The group chairperson or the center chief acts as the convener of committee meetings. The committee supervises daily operations and reviews the economic situation in weekly meetings.

The loans for collective enterprises quickly became popular, but because of widespread failure of these enterprises, the enthusiasm of the members could not be sustained. In 1984, 32 percent of Grameen Bank members participated in collective enterprises; in 1985 that rate was reduced to 17 percent. The share of collective enterprises in total loans jumped from 1.9 percent in 1983 to 8.2 percent in 1984, but fell to 5.1 percent in 1985 and further to 1.4 percent in 1986 (Table 8).

Table 14 shows the importance of various types of activities for which loans were disbursed for collective enterprises. Between 1982 and 1984, nearly one-half of the total loan amount was taken for joint crop cultivation or pisciculture. The amount disbursed for crop cultivation through 1984 was Tk 13 million, which compares favorably with Tk 8 million issued for these purposes as individual loans. The insignificant demand for crop loans by individual bank members is due to the small amount of land owned by members and to the requirement that loans be repaid in weekly installments even though the income from crop cultivation is seasonal. Provision of a larger amount of credit for undertaking collective enterprises induces members to rent land and organize production on a cooperative basis, since they can pay the weekly installments from their regular income from nonfarm enterprises undertaken with individual loans. Thus, in collective enterprises, the Grameen Bank found an avenue of financing crop cultivation and engaging the rural poor in this important production activity. In 1985, crop cultivation accounted for about three-fourths of the loans disbursed for collective enterprises.

---

[45] Fugelsang and Chandler, *Participation As Process*, p. 154.

The failure of collective enterprises to expand as fast as individual enterprises is mainly due to a slack demand for such loans to undertake nonfarm activities or to finance investment in improved technology. Thus the basic purposes of introducing collective enterprise loans (reaping economies of scale and increasing labor productivity) seem to have been defeated.

According to Grameen Bank management, about one-fifth of the collective enterprises undertaken in the initial years failed. The bank attributes these failures to the difficulties of organizing groups with a large number of members, problems in maintaining accounts, distrust among members, unfamiliarity with new techniques, improper planning about the need for working capital to more fully utilize machines, and interference with the rural power structure. In many cases, undertaking collective enterprises led to misunderstanding among members in the centers, and in a few cases the center chief tried to control the money for personal benefit.

An important factor behind the slack demand for credit for acquisition of improved technology may be that the same loan repayment procedures are required for collective loans as for individual loans. Acquisition of machinery and fixed assets is a relatively long-term investment with a long payback period. Grameen Bank credit, on the other hand, has to be fully repaid within one year—a term that is more suitable for financing working capital needs. Some of these investments, such as installation of irrigation equipment, do not generate a regular flow of income, so it is difficult to meet the bank requirement that loans be repaid in weekly installments. The enthusiasm for taking collective enterprise loans for crop cultivation may also die down very soon unless loan repayments are changed from weekly to seasonal installments so that members can repay the loans after harvest.

In 1986 the bank decided that its Technology Division would take up direct management of the collective enterprises.[46] That division is to guide the enterprises to a profit-making position while imparting management and technical training to bank members. For the present, the bank holds a one-fourth ownership in these enterprises. When members become capable enough, the ownership and management of the enterprises will be handed over to them in stages.

Under this arrangement the bank has already taken up the management of the ailing collective enterprises and has purchased the abandoned agricultural machinery, such as power tillers and irrigation equipment. For repair and maintenance of the machinery and equipment, two service centers have been established. The bank has also moved into large-scale fisheries projects by leasing government-owned water bodies on behalf of the landless. In January 1986 the government handed over to the Grameen Bank the management of one such large-scale fisheries project that covers 783 ponds with 1,030 acres of water bodies in a 200-square-mile site. The bank has also leased 300 acres of mangrove land for 10 years from the Ministry of Fisheries and Livestock and plans to develop the area into an ideal shrimp farm, train the landless in shrimp farming, and ultimately hand the farm over to them.

Use of Group Fund

The Group Fund was created to provide loans to members at times of emergency, such as illness or social ceremony, so that

---

[46] Grameen Bank, "Annual Progress Report: 1986."

Table 15—Utilization of the Group Fund, 1983-86

Variable	Unit	1983	1984	1985	1986
Contributions during the year	Tk million	16.0	21.9	33.5	43.1
Cumulative savings by the end of the year	Tk million	16.0	37.9	71.4	114.5
Number of loans	Thousand	14.9	12.9	18.5	n.a.
Share of members taking loans	Percent	n.a.	10.7	10.8	n.a.
Amount of loans taken during the year	Tk million	2.6	6.5	11.0	17.3
Cumulative amount of loans taken by the end of the year	Tk million	4.8	11.3	22.3	39.5
Loans disbursed from Group Fund as a share of cumulative savings	Percent	16.3	17.2	15.4	15.0
Unutilized balance in Group Fund[a]	Tk million	13.4	31.4	60.4	97.3
Unutilized balance as a share of outstanding normal loans	Percent	18.7	17.8	26.8	32.3

Sources: Compiled from Grameen Bank, *Annual Report,* various issues (Dhaka: Grameen Bank, various years); and Grameen Bank, *Consolidated Cumulative Statement as of December 31, 1986* (Dhaka: Grameen Bank, 1987).

Note: n.a. means not available.

[a] This is an imprecise figure. It should have been calculated by deducting the amount of outstanding loans from the amount accumulated in the Group Fund, but the figure for the amount of outstanding loans from the Group Fund is not available. Instead, the amount of the loans issued during the year has been deducted from the accumulated amount.

a borrower does not have to touch capital or resort to local moneylenders (see Chapter 4). The fund is operated by members of the group, who also decide the terms and conditions of the loan. So far, loans have been disbursed from the fund free of interest.

The pattern of utilization of the Group Fund is shown in Table 15. Only 11 percent of members took loans from the fund during each of the two years for which figures are available, and the amount of the loans disbursed varied from 15 to 17 percent of the amount accumulated in the fund. Thus the Group Fund has become an important source of funds for normal operation of the bank. In December 1983 the unused balance in the fund constituted about 19 percent of the amount of outstanding normal loans with borrowers; it rapidly increased to about 32 percent by the end of 1986.

It is difficult to understand why a large proportion of the Group Fund remains unused, since experience indicates that the poor tend to be in constant need of credit (Table 3). One reason may be that the unutilized amount earns an annual rate of interest of 8.5 percent from the Grameen Bank, but if it is lent to members it earns no interest, so the group is reluctant to lend from the fund unless a member is in dire need. But the same restraint could be achieved by imposing interest on the loans. It may be that the group does not want to profit from emergencies of fellow members. Also, since individual members do not have any claim on the amount accumulated in the fund, the profit motive may not operate.

The purposes for which loans have been issued to members from the Group Fund are seen in Table 16. Social and household needs account for nearly one-third of total loans, and health and medical expenses constitute another one-sixth. The share of the loans for these unproductive purposes increased from 45 percent in the 1979-83 period to 51 percent in 1985. Loans are occasionally taken from the Group Fund for the repayment of overdue loans from other sources, but most of the money is used to repay Grameen Bank loans. Presumably, when a member finds it hard to pay the weekly installments because of some genuine problems, the members allow him to take a loan from the fund to alleviate the difficulties and maintain the discipline of the Grameen Bank. However, the share of such loans is very small and declined from 8.0 percent during 1979-83 to only 2.6 percent in 1985.

An important point to note from Table

Table 16—Distribution of Group Fund loans, by purpose for which loans were taken, 1979-85

	1979-83		1984		1985	
Purpose	Amount of Loans	Share of Loans	Amount of Loans	Share of Loans	Amount of Loans	Share of Loans
	(Tk 1,000)	(percent)	(Tk 1,000)	(percent)	(Tk 1,000)	(percent)
Unproductive	2,171	45.2	2,955	45.3	5,606	51.1
Social and household needs	1,166	24.3	1,840	28.2	3,460	31.5
Health and medical expenses	620	12.9	682	10.5	1,857	16.9
Repayment of old loans	385	8.0	433	6.6	289	2.6
Productive	2,635	54.8	3,564	54.7	5,366	48.9
Crop cultivation	694	14.4	1,041	16.0	1,598	14.6
Purchase of raw materials for manufacturing	356	7.4	260	4.0	374	3.4
Repair and maintenance of equipment	416	8.7	442	6.8	497	4.5
Acquisition of fixed capital	188	3.9	329	5.0	785	7.2
Trading capital	941	19.6	860	13.2	1,022	9.3
Collective enterprises	40	0.8	632	9.7	1,091	9.9
Total	4,806	100.0	6,519	100.0	10,972[a]	100.0[a]

Sources: Grameen Bank, *Annual Report*, 1984, 1985 (Dhaka: Grameen Bank, 1985, 1986).

[a] Parts do not add to total because of rounding.

16 is that nearly half of the Group Fund loans were issued for purposes for which members are eligible to take normal loans from the Grameen Bank, so Group Fund loans have not been limited to emergency situations. Since individual loans from the bank have a maximum limit (Tk 5,000), members capable of productively utilizing a larger amount of capital may borrow the additional money from the fund. The members also see the advantages of interest-free loans with flexible repayment procedures. That this kind of borrowing is not more widespread gives the impression that a few influential members may take advantage of the fund for personal benefit.

6

PERFORMANCE IN CREDIT OPERATIONS

Reaching the Target Group

The main objective of the Grameen Bank is to "extend credit facilities to poor men and women for creating opportunities for self-employment for the vast unutilized and underutilized manpower resources."[47] Thus the Grameen Bank is a credit program targeted to the poor for improvement of their economic condition. It is generally recognized that under existing socioeconomic conditions, it is difficult to reach the poor with resources for development. The general experience of developing countries is that the poor have gained very little from the expanding supply of agricultural credit, which is provided at a rate of interest much below the opportunity cost of capital. In recent literature it has been argued that the low rate of interest generates excess demand for capital from which the rich gain proportionately more because of their connections with local officials and their capacity to apply political pressure.[48]

The Grameen Bank target group is defined as persons belonging to households that own less than 0.5 acre of cultivable land. Table 17 shows the distribution of sample borrowers according to the amount of cultivated land owned, as reported by them to research investigators during a 1985 field survey of 975 randomly selected borrowers from all districts under Grameen Bank operation. Only 4.2 percent of the borrowers belonged to nontarget-group households. In a 1982 survey of 611 borrowers, the proportion of nontarget-group

Table 17—Distribution of borrowers, by amount of cultivated land owned, 1985

Amount of Cultivated Land Owned	Male Borrowers		Female Borrowers		All Borrowers	
	Number	Percent	Number	Percent	Number	Percent
(acres)						
None	264	59.9	379	71.0	643	66.0
Less than 0.10	43	9.8	31	5.8	74	7.6
0.10–0.49	111	25.2	106	19.9	217	22.3
0.50–0.99	18	4.1	15	2.8	33	3.4
1.00–2.49	5	1.1	2	0.4	7	0.7
2.50 or more	0	0.0	1	0.2	1	0.1
Total	441	100.0[a]	534	100.0[a]	975	100.0[a]

Source: Survey of 975 borrowers.

[a] Parts do not add to total because of rounding.

---

[47] Yunus, "Experiences in Organising Grass Root Initiatives," p. 9.

[48] Dale W Adams and Douglas H. Graham, "A Critique of Traditional Agricultural Credit Projects and Policies," *Journal of Development Economics* 8 (June 1981): 347-366; and Dale W Adams and Robert C. Vogel, "Rural Financial Markets in Low-Income Countries: Recent Controversies and Lessons," *World Development* 14 (April 1986): 477-487.

Table 18—Distribution pattern of landownership and landholding, 1985

Amount of Land Owned and Operated	Landownership			Land Operation		
	Male	Female	All	Male	Female	All
(acres)	(percent of total borrowers in sample)					
None	6.6	11.4	9.2	42.0	56.7	50.0
Less than 0.10	36.7	44.6	41.0	7.5	5.4	6.4
0.10–0.49	45.1	33.7	38.9	24.5	19.9	21.9
0.50–0.99	7.9	6.7	7.3	15.2	10.5	12.6
1.00–2.49	3.4	2.8	3.1	9.8	6.7	8.1
2.50 or more	0.3	0.8	0.5	1.1	0.5	0.9
	(acres)					
Average	0.23	0.22	0.23	0.38	0.28	0.32

Source: Survey of 975 borrowers.

households was 5.6 percent.[49] Thus, even after the rapid expansion of the bank's coverage, not only has the membership remained confined mostly to the target group, but there has in fact been an improvement in this respect. Indeed, most Grameen Bank members are extremely land-poor. The 1982 survey found that two-thirds of them did not own any cultivated land. The 1985 survey sustained this result.

It could be argued that ownership of cultivated land is not the proper criterion for identifying the poor. A borrower may have noncultivable land, such as fish ponds, orchards, or homestead, and can also rent land that could provide a good source of income. The pattern of distribution of landownership and landholding reported in Table 18 shows that total land owned or operated is also very insignificant for most of the borrowers. The average amount of land owned in 1985 was only 0.23 acre, and the average amount of land operated was 0.32 acre. Members who owned more than 1.0 acre of land were only 3.6 percent of the sample—down from 5.2 percent in the 1982 survey. Members who operated more than 1.0 acre (by renting land) were only 9.0 percent of the sample, compared with 10.4 percent in 1982.

There are several factors behind the success of Grameen Bank in reaching its target group. Perhaps the most important one is the selection of the extreme poor as the bank's target. Although accurate information about the landownership status of a household can be concealed, the target group is so poor that its members can be easily identified by such characteristics as their appearance and clothing.

Second, the formation of groups and their compulsory weekly meetings have helped the bank to keep out of its domain the economically better off. The relatively affluent would feel ashamed to mix with the extreme poor on a regular basis.

Third, crop production is usually the major source of income for households that own more than 0.5 acre of cultivated land, and this generates income for the household only after the crop is harvested. With the seasonal flow of agricultural income, it is difficult to maintain repayment of a loan in weekly installments as required by the bank. This seasonal income also checks the tendency on the part of the nontarget group, whose main occupation is farming, to apply for Grameen Bank loans, which they would take mainly for the purpose of crop cultivation.

---

[49] Hossain, *Credit for the Rural Poor*, pp. 57-63.

Finally, although the bank charges the same nominal rate of interest as the other specialized credit institutions (16 percent a year), the effective cost of the loan to the borrower is higher. Each bank member has to deposit 5 percent of the loan in the Group Fund (this deposit is 10 percent of the average amount outstanding for the year and cannot be reclaimed by the member) and 25 percent of the interest charges in the Emergency Fund. Although the contributions to the Group Fund and Emergency Fund cannot be treated as income by the bank, the effective cost of a loan to the borrower comes to about 33 percent[50] compared with the 16 percent rate of interest charged by other banks. The higher cost of credit also keeps the economically better off away from the Grameen Bank.

One issue to be considered is whether the high implicit rate of interest might constrain the expansion of credit from the Grameen Bank, since this rate cuts down the number of activities that can be profitably undertaken with a bank loan. To address this issue, it is necessary to estimate the rate of return on investment for various activities that are undertaken with the loans. This is, however, an extremely difficult task because of the problems involved in estimating the amount of labor used in informal activities. These activities provide mostly self-employment to workers engaged in multiple occupations. Also, different household members engage in a number of activities, mutually helping each other in their tasks. Collection of accurate information on labor allocated to different activities would require a survey on time allocation for each member of the household.

An additional problem is that widespread underemployment makes the task of estimating the cost of family labor difficult. The 1982 study mentioned above attempted to estimate the rate of return on investment on the basis of a number of assumptions that are of questionable validity.[51] The rate of return on investment was calculated by imputing the cost of family labor as equal to the agricultural wage rate at 86 percent for livestock and poultry raising, 61 percent for trading, and minus 38 percent for processing and manufacturing activities. In the manufacturing group, only weaving, pottery, and dairy products had a positive rate of return.

Even at a negative rate of return, loans are taken for processing and manufacturing enterprises because they enable employment of a household's female labor, which has low opportunity cost. When family labor was imputed at the market wage, the rate of return on investment was estimated by the 1982 study at 57 percent for male-borrower households and minus 87 percent for female-borrower households. But when family labor was imputed at a cost of 80 percent of the market wage rate, the rate of return on investment for female-borrower households was 27 percent. In the rural labor market, however, women receive only 30-40 percent of the wage paid to male workers.[52] If labor were imputed at an opportunity cost of 60 percent of the wage rate, the rate of return on investment would increase to 145 percent.

These calculations show the high sensitivity of the estimate of the rate of return on investment to assumptions about the opportunity cost of labor. Thus, as long as family labor remains underutilized and has low opportunity cost, the Grameen Bank's loans at the implicit high rate of interest will remain attractive to the poor. When the labor market becomes tight, and prospective borrowers can utilize all their available labor at a market wage higher than the return on family labor in bank-financed enterprises,

---

[50] On a loan of Tk 100, the borrower would have to pay Tk 8 in interest (at 16 percent on an average balance of Tk 50) plus Tk 2 as a contribution to the Emergency Fund. Thus the principal and the interest amount to Tk 110. The borrower would receive initially only Tk 95, as Tk 5 is deducted for the Group Fund. Thus the borrower would pay Tk 15 in addition to the amount of Tk 95 received. The average balance in hand would be Tk 45 (Tk 95 minus Tk 50 paid in the first 25 weeks). Therefore, the implicit annual rate of interest is 33.3 percent (15 divided by 45).

[51] Hossain, *Credit for the Rural Poor,* pp. 77-94.

[52] R. I. Rahman, *The Wage Employment Market,* pp. 53-57; and Hossain, "Employment and Labour," p. 15.

Table 19—Occupation of members and heads of household as stated on membership application form

	Members		Heads of Household	
Occupation	Principal Occupation	Principal Plus Secondary Occupation	Principal Occupation	Principal Plus Secondary Occupation
	(percent of members)			
None, or not stated	41.6	41.6	5.4	5.4
Crop cultivation	7.3	17.3	15.3	28.0
Agricultural labor	8.4	10.1	22.3	26.3
Livestock, poultry raising, and fisheries	0.1	0.7	0.6	1.1
Industry	15.1	25.4	14.0	19.4
Trading and shopkeeping	19.2	26.2	25.3	34.6
Transport and construction	2.8	3.6	5.0	6.1
Other services	5.4	7.4	12.1	14.1
Total	100.0[a]	132.1[a,b]	100.0	135.0[b]

Source: Unpublished data contained in approximately 4,700 Grameen Bank membership application forms.

Note: The head of household is not necessarily a member of the Grameen Bank. Most of the male members are heads of household, but for most female members the head is a different person.

[a] Parts do not add to total because of rounding.

[b] These figures show the index of multiple occupations, indicating that 35 percent of the household heads and 32 percent of the Grameen Bank members had more than one occupation.

the demand for Grameen Bank loans will slacken. Since the higher-income group has better job opportunities and higher value for leisure, such high-cost loans are less attractive to them than to the poor.

Coverage of Occupational Groups

Table 19 provides information about the occupational backgrounds of Grameen Bank members and those of heads of households to which members belonged at the time of application for bank membership. This information was obtained by processing approximately 4,700 loan application forms kept at Grameen Bank offices for the branches selected for this study. About 42 percent of the members had no income-earning occupation (though some may have been unpaid family workers in household enterprises) at the time of application for the first loan. Thus the loans helped to generate new jobs for a large proportion of the members. Only 5 percent of the heads of borrower households, however, reported having no employment at the time of joining the bank. This discrepancy occurs because most household heads are male and must do something to make a living. But the majority of Grameen Bank members are women, a large proportion of whom are dependents in the household. A Grameen Bank loan enables them to participate in productive activities and lowers the dependency ratio in the family.

Among those applicants who were employed, the majority (59.0 percent) were involved in industry and trading, and very few (14.4 percent) had agricultural labor as their principal occupation. Cultivating family farms and working as agricultural wage laborers were the principal occupations of 15 and 22 percent of the heads of households, respectively. According to the 1983-84 agricultural census, about two-thirds of the Grameen Bank target group were agricultural-labor households.[53] This compari-

---

[53] In 1983/84 there were an estimated 13.8 million rural households, of which 6.2 million belonged to the Grameen Bank target group. The number of agricultural-labor households was estimated at 5.5 million, of which 3.78 million belonged to the Grameen Bank target group. See Bangladesh, *Census of Agriculture and Livestock,* p. 81.

Table 20—Average size of current loans, by length of bank membership, 1985

Number of Loans Taken	Number of Borrowers	Share of Borrowers	Average Size of Loan
		(percent)	(Tk)
One	276	28.3	2,181
Two	378	38.8	3,205
Three	171	17.5	3,702
Four	91	9.3	3,324
Five or more	59	6.1	3,644
Total	975	100.0	3,040

Source: Survey of 975 borrowers.

son indicates that households engaged in trading and manufacturing have been reached relatively more than those occupied in agricultural wage labor. Since agricultural wage laborers are the poorest among the poor, it appears that the Grameen Bank has had limited success in serving the extreme poor within the landless group.

An important factor behind the limited success of the bank in reaching agricultural wage laborers, compared with other occupational groups, could be the Grameen Bank emphasis on investment in activities that generate regular income. Wage laborers are timid about coming forward when a new branch is being established because they are used to working for others and are fearful of venturing into activities that need some entrepreneurial skills. They would like to join the bank later, when they have gathered sufficient courage by observing the experience of others, but by that time it is difficult to enter a group. Membership in a group is permanent unless a member leaves voluntarily. A Grameen Bank branch has a fixed number of workers and a bank worker has the capacity to serve 200-250 members. Once the capacity of the branch is reached, it becomes difficult for a person to join the bank. The Grameen Bank could address this problem by considering a policy of graduating older members in order to extend bank coverage to less entrepreneurial, poorer households who would like to join later.

However, the Grameen Bank may indirectly contribute to increases in the income of those agricultural wage laborers who are left out. Members who use their loans to pursue nonfarm activities withdraw from the agricultural labor market, thus reducing the supply of agricultural workers. This increases the number of days of agricultural employment available for the remaining workers and puts an upward pressure on the wage rate, thereby increasing total wage earnings for nonparticipants within the bank's target group.

Size of Loans

The average size of current loans received by sample borrowers in the 1985 survey was estimated at Tk 3,040—Tk 3,279 for men and Tk 2,843 for women. On average, female borrowers thus received about 13 percent less than male borrowers. The Grameen Bank has set Tk 5,000 as the maximum amount that can be approved for an individual loan. The survey found that about 14 percent of current loans were Tk 4,000 or more, and about 12 percent were Tk 1,500 or less. Nearly 50 percent of the loans to male members were between Tk 2,500 and Tk 4,000, while about 40 percent of loans to female members were in this range.

In general, new members received smaller loans than old members. Members who had already taken five or more loans composed about 6 percent of the sample and they received, on average, about two-thirds more than those who were first-time borrowers (see Table 20). The marginal increase in the size of the loan, however, declines sharply with the length of membership. Second-time borrowers received an average of about Tk 1,024 more than first-time borrowers, but the increase for third-time borrowers was only about Tk 500. Beyond the third loan, the average loan amount was in fact smaller than that for third-time borrowers.

This phenomenon can be explained as follows. With every repeat loan, the amount of equity in the capital of the enterprise

Table 21—Loan distribution, by purpose of loan and sex of borrower, 1985

Purpose of loan	Male Borrowers	Female Borrowers	All Borrowers
	(percent of current loan amount)		
Crop cultivation	4.0	4.6	4.3
Livestock, poultry raising, and fisheries	18.5	44.6	31.9
Processing and manufacturing	18.6	29.9	24.4
Trading and shopkeeping	49.7	18.7	33.8
Transport and other services	9.2	2.2	5.6
Total	100.0	100.0	100.0

Source: Survey of 975 borrowers.

increases, but the rate of return on capital declines because of the higher opportunity of family labor due to fuller utilization of labor and increased value of leisure as per capita income increases. Hence the demand for new loans declines after a few years.

The average size of loans for the major activities varied according to the purpose for which a loan was taken and the sex of the borrower. For most of the activities, female members received smaller loans than male members. The average size also varied with the educational status of the members. Illiterate members received about 25 percent less than those with secondary or higher education.

Use of Loans

Table 21 presents the survey findings on distribution of loans according to the purpose for which the loans were taken. The results are broadly similar to those obtained from processing the official records of the Grameen Bank, as reported in Tables 8, 9, and 10. For male members, about 50 percent of the amount of the loans was taken for trading and shopkeeping, while for female members, about 75 percent of the loan amount was for livestock and poultry raising and for processing and manufacturing activities.

Table 22 shows the pattern of utilization of Grameen Bank credit as stated by the borrowers.[54] The important point to be noted is that only an insignificant proportion of the loans was diverted to consumption and other household needs. Only 0.7 percent of the money was used for consumption purposes, 4.3 percent for social ceremony, and 1.6 percent for repair of housing. Ninety-four percent of the money was used for investment in various agricultural and nonagricultural activities. About 4.3 percent of the total amount was borrowed for crop cultivation (Table 21), but 6.4 percent was utilized for this purpose, indicating marginal diversion of nonfarm loans into farming activities. Thirty-five percent of the total amount was used for trading and shopkeeping, and 32 percent for livestock and poultry raising—almost the same proportion that was borrowed for these purposes. It appears that the diversion of loans to consumption and social ceremony took place primarily at the expense of investment in processing and manufacturing activities.

The diversion of money across sectors will be better seen in Table 23, which shows the utilization pattern of loans by their initial purpose. Loans taken for shopkeeping and for transport and other services were mostly used for these purposes. But a large portion of the money taken for processing and manufacturing activities was diverted

---

[54] It should be recognized here that the loans are fungible. The amount of money received could have substituted for own capital utilized in the enterprise before the loan was taken, which would now be available for consumption or meeting other household needs.

Table 22—Pattern of loan utilization, by sex of borrower, 1985

Utilization	Male Borrowers	Female Borrowers	All Borrowers
		(percent of current loan amount)	
Nonproductive	4.9	8.1	6.6
Consumption	0.5	0.9	0.7
Social ceremony	3.5	5.0	4.3
House repair	0.9	2.2	1.6
Productive	95.1[a]	91.9[a]	93.5
Crop cultivation	7.4	5.5	6.4
Livestock raising	19.9	33.1	26.8
Poultry raising	3.9	5.7	4.9
Processing and manufacturing	11.6	18.3	15.1
Trading and shopkeeping	43.7	27.3	35.1
Transport operations and other services	8.7	2.1	5.2
Total	100.0	100.0	100.0[a]

Source: Survey of 975 borrowers.

[a] Parts do not add to total because of rounding.

to livestock and poultry raising (26 percent) and trading (23 percent). This diversion reflects the low rate of return on capital for processing activities compared with that for trading and livestock raising.

Repayment Behavior of Borrowers

The traditional banking system rarely provides credit to the poor, since (1) they cannot provide collateral against which the loan can be granted; (2) they do not maintain accounts for preparation of bankable projects; and (3) they have a low repayment capacity because, at their subsistence level, the compulsion to consume the additional income is great.[55] The Grameen Bank is providing loans to these people without any collateral. It is thus important to investigate the repayment behavior of Grameen Bank members.

The monthly statement of the Grameen Bank for February 1987 reported that 97.4 percent of the money was recovered within one year after the date of issue and 98.6 percent within a period of two years.[56] The bank treats as overdue any loan amount that is not repaid within two years, since the loanable fund is borrowed for that term. Thus the bank regarded only 1.4 percent of loans as overdue. In actual practice, however, the borrower is expected to fully repay the loan within one year. From this point of view, the overdue amount was 2.6 percent.

An independent estimate of the loan repayment performance was made by asking the sample borrowers how many weekly installments had already been paid at the time of the interview and estimating how many were due to be paid from the date of issue of the loan. Each borrower has a passbook in which this information is recorded. The interviewer was asked to verify the response of the borrower by checking this passbook. The amount overdue is derived by multiplying the number of overdue installments (installments due to be paid minus the installments actually paid at the

---

[55] Grameen Bank, *Consolidated Cumulative Statement as of February 28, 1987* (Dhaka: Grameen Bank, 1987).

[56] See, for example, the lenders' views about handling small industry loans in M. U. Ahmed, "Financing Rural Industries," pp. 75-76.

Table 23—Pattern of loan utilization, by purpose of loan, 1985

	Purpose of Loans					
Utilization	Crop Cultivation	Livestock, Poultry Raising, and Fisheries	Processing and Manufacturing	Trading	Shopkeeping	Transport Operations and Other Services
			(percent of current loan amount)			
Nonproductive	1.0	5.6	7.1	6.5	5.7	5.6
Consumption	0.0	0.6	1.2	0.4	0.6	0.6
Social ceremony	1.0	3.2	5.1	3.7	5.1	5.0
House repair	0.0	1.8	0.8	2.4	0.0	0.0
Productive	99.0	94.4	92.8	93.5	94.3	94.4
Crop cultivation	72.0	4.4	1.8	4.9	6.4	3.3
Livestock, poultry raising, and fisheries	4.5	66.4	25.8	12.2	1.1	2.0
Processing and manufacturing	0.8	12.5	41.9	2.2	0.7	0.0
Trading and shopkeeping	21.7	10.4	22.6	72.4	86.1	2.0
Transport operations and other services	0.0	0.7	0.7	1.8	0.0	87.1
Total	100.0	100.0	100.0[a]	100.0	100.0	100.0

Source: Survey of 975 borrowers.

[a] Parts do not add to total because of rounding.

time of the interview) by the amount to be paid per week. Thus a loan is treated as overdue even before the maturity period of one year if the borrower has not been regular in paying the weekly installments. Table 24 shows that only 0.5 percent of the amount of the loans was overdue beyond one year after issue of the loans to sample borrowers, and the amount unpaid in overdue weekly installments (before the end of the year) was only 3.3 percent of the amount borrowed. The sample survey thus confirms the excellent recovery performance shown in official records of the Grameen Bank.

Table 24 also shows that loan repayment performance was almost the same for male and female members, but varied across landownership groups and with length of membership in the bank. A large proportion of overdue loans was with nontarget-group households and longtime borrowers. Members who owned more than 1 acre of cultivated land had about 7.2 percent of the loan amount in overdue installments, compared with only 2.7 percent for members who owned no cultivated land. The amount overdue beyond one year was 2.4 percent for those with more than 1 acre, compared with only 0.4 percent for those with no land. Fourth-time borrowers had 9.5 percent of the loan amount in overdue installments, compared with 0.4 percent for first-time borrowers and 1.2 percent for second-time borrowers. Thus the longtime members appeared to be less committed to maintaining regular repayment. But all groups of borrowers had very little overdue beyond one year after the date of disbursement.

The repayment behavior of different groups of borrowers is seen more clearly in Table 25. Seventy-eight percent of borrowers had no overdue installments at the time of the 1985 survey. This figure was found to be the same as in a 1982 survey, thus showing the stability of the estimate.[57] More than one-third of the overdue cases

---

[57] Hossain, *Credit for the Rural Poor*, p. 69.

Table 24—Extent of overdue loans, by type of borrower, 1985

Type of Borrower	Total Amount of Loans to Group	Overdue Installments[a]		Installments Overdue Beyond 52 Weeks	
		Amount	Share of Loan Amount	Amount	Share of Loan Amount
	(Tk 1,000)		(percent)	(Tk 1,000)	(percent)
Sex					
Male	1,441.5	49.7	3.4	4.8	0.3
Female	1,512.5	49.1	3.2	9.3	0.6
Landownership (acres)					
0.0	1,429.5	38.8	2.7	5.5	0.4
0.01–0.49	843.5	23.4	2.8	0.5	0.1
0.50–0.99	387.5	15.4	4.0	1.3	0.4
1.00 or more	293.5	21.2	7.2	6.9	2.4
Number of loans taken					
One	595.5	2.1	0.4	0.0	0.0
Two	1,211.5	14.3	1.2	3.0	0.2
Three	633.0	41.9	6.6	7.2	1.1
Four	299.0	28.5	9.5	3.9	1.3
Five or more	215.0	11.9	5.5	0.0	0.0
Total	2,954.0	98.7[b]	3.3	14.1[b]	0.5

Source: Survey of 975 borrowers.

[a] The amount due to be paid minus the amount actually paid at the time of the survey.

[b] Parts do not add to total because of rounding.

had one or two unpaid installments. Cases with 10 or more overdue installments were estimated at only 5.1 percent, which is an improvement over 1982, when this figure was estimated at 9.3 percent. The repayment performance was best for women borrowers—81 percent of them had no overdue installments, compared with 74 percent for men.

A sharp difference in repayment performance is noted among borrowers differentiated by length of membership in the bank. More than 62 percent of the members who had already taken five or more loans from the bank had overdue installments at the time of the 1985 survey, compared with only 3.3 percent for first-time borrowers and 10.5 percent for second-time ones. A

Table 25—Distribution of borrowers, by overdue and paid installments, 1985

Installments	Number of Loans Taken					Sex of Borrowers		
	One	Two	Three	Four	Five or More	Male	Female	Male and Female
	(percent of borrowers)							
Overdue installments	3.3	10.5	39.1	67.1	62.7	25.6	18.7	21.8
1–2	2.2	4.7	10.5	20.9	33.9	11.6	5.7	8.3
3–5	0.4	3.4	6.4	18.7	16.9	5.4	5.2	5.3
6–9	0.0	0.8	6.4	15.4	5.1	4.1	2.2	3.1
10 or more	0.7	1.6	15.8	12.1	6.8	4.5	5.6	5.1
No overdue installments	96.7	89.5	60.9	32.9	37.3	74.4	81.3	78.2
Exact number of installments paid	78.2	75.3	56.7	25.2	32.2	63.0	67.8	65.6
Advance installments paid	18.5	14.2	4.2	7.7	5.1	11.4	13.5	12.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Survey of 975 borrowers.

significant proportion of new borrowers pay installments in advance, presumably to become eligible for another, larger loan as soon as possible. This may be partly due to underestimation by both lender and borrower of the first loan amount that the latter can profitably use. Once in business, the borrower realizes the mistake and wants a larger loan. Since there is a tendency to repay from principal rather than from income, Grameen Bank has ruled that a loan cannot be fully repaid earlier than 40 weeks from the date of issue.

The recovery of Grameen Bank loans must be considered excellent when compared with the performance of other credit programs in Bangladesh. According to the agricultural credit review of 1983, conducted jointly by the government of Bangladesh and the International Development Association, the nationalized commercial banks showed 52 percent of their outstanding agricultural loans as overdue in June 1980 and 61 percent in June 1981.[58] Nearly half of the amount was overdue by more than two years. The agricultural development bank, which has a relatively better record of repayment, had 17 percent of loans overdue at the end of June 1982.

Some of the factors that have contributed to the excellent recovery of Grameen Bank loans are (1) the personal interest and close supervision of activities in the field by the managing director, who is also the founder of the bank; (2) the dedicated services of the bank workers, most of whom have taken the job as an opportunity to provide services to the poor rather than simply to earn an income for themselves; (3) the provision of loans for activities that generate regular incomes; (4) the procedure of collecting repayments in small amounts through weekly installments; and (5) the genuine credit need of the poor for profitable income-earning opportunities perceived by them.

In spite of the large increase in the number of bank branches, the managing director still maintains his personal contacts with the branches through frequent field visits and attendance at workshops. Workshops are arranged to bring together representatives of borrowers, center chiefs, and bank staff to discuss issues of bank operation and social matters such as family planning, marriage expenses, education of children, health and sanitation, and relations with local power holders. Top Grameen Bank managers attend these workshops to keep in touch with problems in the field. The managing director is also assisted in the field by a dedicated cadre of mid-level officers, many of whom were his students and were developed by him during the pilot experiment of the project near Chittagong University. With the increase in the number of bank branches, these officers now work as his primary contacts, keeping him constantly in touch with the problems of bank branches and the performance of the managers and bank workers. A decentralization of administrative and decisionmaking processes has also followed the expansion of the bank (see Chapter 4).

Bank employees are recruited after careful scrutiny of their knowledge of the living conditions of the rural poor and interest in serving them. Before employees are assigned to a branch, they are given intensive training for six months, mostly in the field, where they not only learn their duties and the rules and procedures followed by the Grameen Bank, but also observe and study the socioeconomic conditions in the countryside and the needs of the poor. The employees are then sent to existing branches to work as trainees. During this time they observe the operation of the bank, assist their counterparts in the branch, and write case studies on the life of the rural poor. Most employees who find the work difficult and not suitable for them leave the Grameen Bank at this time. Only those who pass the test of hard work are sent to their new duty stations as independent workers. Such intensive training helps build a dedicated cadre of bank employees who are really the key to the success of the Grameen Bank. They have not yet been influenced by the widespread corruptive practices elsewhere in the banking system.

---

[58] Bangladesh/International Development Association, *Bangladesh Agricultural Credit Review, Statistical Annex* (Dhaka: Government of Bangladesh/IDA, 1983).

As already noted, Grameen Bank credit finances basically noncrop activities. These activities generate regular incomes, and as the loans are recovered in small installments on a regular basis, the clients find repayment easy. If the loans had to be repaid in one installment after one year, as is the case with agricultural lending in the country, the borrowers would find it difficult to accumulate the amount because, at their level of income, there is a tendency to divert increased income to consumption.

7

ECONOMIC EFFECTS

Methodological Issues

In the absence of comparable benchmark data, the effect of the Grameen Bank's operation on income and poverty had to be estimated through a "with" and "without" comparison of information collected in a one-time survey of households in five project villages covered by the bank and two control villages outside the bank's area of operation. The sample households were classified into four groups: (1) Grameen Bank members in project villages, (2) nonparticipating households within the target group (target-group households own less than 0.5 acre of cultivated land), (3) target-group households in the control villages, and (4) nontarget-group households (those who own 0.5 acre or more) in both project and control villages. Groups 2 and 3 have been used as alternative controls for comparison of the average values of the relevant variables with those for group 1.

This methodology is not without pitfalls.[59] There are problems with using either of the two groups as a control. The target-group nonparticipants in the project villages would have similar resource bases, but some of their sources of income would be affected by the bank's intervention. For example, income from agricultural labor would be affected by the withdrawal of bank members from the agricultural labor market, while the participants' access to credit for undertaking nonfarm enterprises might lead to some redistribution of nonfarm income from nonparticipant to participant households within the project village. The selection of control households from the target group in villages outside areas of the Grameen Bank's operation would eliminate these problems, but in practice it is difficult to find control villages that are exactly similar to project villages in all respects. The survey found that the control villages had a larger proportion of landless and near-landless households than the project villages, and that the average amount of land owned was less for the control villages, although the average amount of cultivated land owned was similar, because of greater participation of control households in the tenancy market.

The estimates obtained from the comparison may also suffer from the sample selection bias. It could be argued that the Grameen Bank initially moves into villages that have relatively high levels of income, as the market for nonfarm goods and services would be larger there and hence the demand for loans would be greater. Similarly, Grameen Bank participants may be better entrepreneurs than the nonparticipants and hence were probably better off before the intervention of the bank. A simple comparison of the project and control groups may thus overestimate the true effect.

In order to see the extent of the sample selection bias, a probit model was run by

---

[59] Analysts of rural financial markets denounce the value of studies of the effect of credit programs. Von Pischke and Adams argue that measurement of the effects of a credit program should focus on "additionality," which is the difference between what happened under a project and what would have happened without it, and additionality is very difficult to measure at the farm level. David and Meyer argue that credit effect is very hard to isolate with the use of common social science research tools and the value of credit as a tool for development can be easily overestimated by ignoring problems such as fungibility of loan money and the interdependence of farm and household decisionmaking. See J. D. Von Pischke and Dale W Adams, "Fungibility and the Design and Evaluation of Agricultural Credit Projects," in *Rural Financial Markets in Developing Countries,* ed. J. D. Von Pischke, Dale W Adams, and Gordon Donald (Baltimore and London: Johns Hopkins University Press, 1983), pp. 74-83; and Cristina C. David and Richard L. Meyer, "Measuring the Farm Level Impact of Agricultural Loans," in *Rural Financial Markets,* ed. Von Pischke, Adams, and Donald, pp. 84-95.

Table 26—Statistical difference between project and control group households according to selected exogenous variables, 1984/85

	Sample of Members with Target-Group Nonparticipants in Project Villages (N = 137)			Sample of Members with Target Group in Control Villages (N = 132)		
Variable[a]	Regression Coefficient	t-ratio	Significance Level	Regression Coefficient	t-ratio	Significance Level
Constant	1.430	2.040	0.041	6.310	0.02	0.984
FSZ	0.056	0.960	0.339	0.099	1.54	0.123
AGE	−0.017	−1.830	0.067	−0.035	−3.25	0.001
EDN	0.022	0.820	0.414	0.065	2.30	0.022
LND	−0.470	−1.580	0.115	0.014	0.11	0.917
CPTLP	0.046	1.089	0.277	−0.005	−0.23	0.817
OCPP	−1.112	−1.870	0.062	−5.720	−0.02	0.986
$\bar{R}^2$	0.090			0.120		
Log-L	−94.900			−91.400		

Source: Household survey in project and control villages.

[a] FSZ is the number of family members; AGE is the age of the household head; EDN is the number of years of formal schooling completed by the household head; LND is the acreage owned by the household; CPTLP is the value of nonland fixed capital before joining the bank; and OCPP is a dummy variable representing the participant's major occupation before joining the bank.

regressing a dichotomous dependent variable, which measures participation in the Grameen Bank (1 for participants and 0 for nonparticipants), to a number of exogenous variables that are not supposed to be affected by the intervention made by the bank. The following regression model has been estimated:

$$MMBR = f(FSZ, AGE, EDN, LND, CPTLP, OCPP),$$

where MMBR is a dummy variable with value 1 for participants and 0 for nonparticipant households, FSZ is the number of family members, AGE is the age of the household head, EDN is the number of years of formal schooling completed by the household head, LND is the amount of land owned by the household (acres), CPTLP is the value of nonland fixed capital (in Tk 1,000) before joining the bank, and OCPP is a dummy variable representing the participant's major occupation before joining the bank, taking value 1 for agriculture and 0 for nonagriculture.

The results of the exercise for the two sets of samples (participants with the target-group nonparticipants in project villages, and participants with the target group in the control villages) are presented in Table 26. The Grameen Bank participants had larger families, were younger, better educated, and pursued more nonagricultural activities than the nonparticipants in both project and control villages. But within the project villages, the difference between the two groups was not statistically significant at less than 5 percent. Only with respect to age and occupation was the difference weakly significant at less than 10 percent probability. Compared with the target group in the control villages, the project group was significantly different with respect to age (younger) and education (higher levels of schooling). Thus the results obtained from comparison of the project group with control group 1 should not be seriously biased, but the positive results obtained from comparison with control group 2 may be biased upward.

Effect on Credit Markets

One of the basic premises of the Grameen Bank is that the poor nonfarm operators, particularly those employed in cottage industries and petty trade, have to depend on village moneylenders *(mohajons)* for capital. It is well known that the *mohajons* charge very high rates of interest on these informal loans (Table 3). An interest rate of 10 percent a month is common in informal markets. The *mohajons* sometimes control the input and product trade, and the nonfarm operator facing a shortage of capital sometimes gets raw materials on credit from a moneylender against the stipulation that the operator will sell the output through the lender.[60] By exercising monopoly control in the interlinked input, product, and capital markets, the *mohajon* can extract a large proportion of the current income of the borrower.[61] Lack of capital may also force many nonfarm operators to sell their services as laborers for a very low wage. This is observed especially in paddy husking and petty trade. Grameen Bank credit may enable nonfarm operators to become independent of the rural financial and market intermediaries and help this poor group to retain the income now extracted by the moneylenders.

The Grameen Bank collects information on the nature and extent of current indebtedness of prospective members by asking them to report the sources and amount of current debt (including credit that is not overdue) on the membership application form. This information may be underreported because of fear that the bank would not provide credit to an indebted household. Also, credit obtained in kind, in the form of raw materials, may not be reported, as this is not normally considered to be debt. This information was processed for the members of the branches under study. It was found that only 0.7 percent of Grameen Bank members had received credit from institutional sources before joining the bank (not shown in the table). Even the informal lenders do not regard these households as creditworthy. Only 5.7 percent of member households reported that they had debts with noninstitutional sources—3.4 percent from *mohajons,* 2.0 percent from friends and relatives, and 0.3 percent from other informal sources. The average size of the debt for an indebted household was Tk 1,502—Tk 964 with *mohajons* and Tk 2,684 with friends and relatives.

Since raw materials obtained on credit are not generally regarded as loans, the sample borrowers covered in the 1985 survey were asked to report the size of the working capital employed by them in an enterprise before joining the bank and the amount financed by noninstitutional sources. This information, too, may be inaccurate, especially for repeat borrowers, because of problems associated with memory recall. Nineteen percent of households reported receiving noninstitutional credit before joining the Grameen Bank (see Table 27). This proportion was reduced to less than 3 percent as a result of intervention by the bank. Thirty percent of the working capital of borrowers was financed with noninstitutional credit before joining the bank, but this was reduced to only 3 percent for 1985, indicating the overwhelming effect of the Grameen Bank on the operation of the informal credit market.

The effect of the bank on the rural credit market can be better assessed from Table 28, which presents the findings of the household survey in the project and control villages on the amount of loans taken from various sources during 1984/85. About 94 percent of member households received an average of Tk 3,300 from institutional (Grameen Bank) sources. The dependence of participants on noninstitutional sources was low when compared with similar groups of households in the project and control villages. Only 6 percent of Grameen Bank members received loans from noninstitutional sources, compared with about 18 percent of the bank's target group in the control villages and 20 percent among nonmembers

---

[60] See M. U. Ahmed, "Financing Rural Industries," p. 71.

[61] Atiq Rahman, "Usury Capital and Credit Relations in Bangladesh Agriculture: Some Implications for Capital Formation and Capitalistic Growth," *The Bangladesh Development Studies* 12 (No. 2, 1979): 1-46. For studies on eastern India, which has socioeconomic environments similar to those in Bangladesh, see P. K. Bardhan and A. Rudra, "Interlinkage of Land, Labor and Credit Relations: An Analysis of Village Survey Data in East India," *Economic and Political Weekly* 13 (February 1978): 367-384.

Table 27—Noninstitutional credit as a source of working capital, 1985

Type of Borrower	Before Joining Grameen Bank: Households Receiving Noninstitutional Credit	Before Joining Grameen Bank: Working Capital Financed with Noninstitutional Credit	During Year of Survey: Households Receiving Noninstitutional Credit	During Year of Survey: Working Capital Financed with Noninstitutional Credit
	(percent)			
Sex				
Male	23.6	29.7	5.2	4.3
Female	15.4	31.3	0.7	0.4
Occupation				
Industry	23.6	16.5	4.9	4.5
Trading and shopkeeping	24.5	30.8	3.8	3.2
Other	12.2	51.4	0.7	0.4
Total	19.1	30.0	2.8	3.0

Source: Survey of 975 borrowers.

within the target group in the project villages. Most institutional credit outside of the Grameen Bank was received by nontarget-group households; only 3 percent of the target group (in the combined categories B and C in the table) received such loans, compared with 28 percent of the nontarget group. Outside the bank, only 9 percent of households received institutional credit, which accounted for about 52 percent of the total amount of loans received by these households. With Grameen Bank intervention, the proportion of households receiving institutional credit increased to 30 percent and the share of institutional loans in total loans increased to about 78 percent.

Effect on Capital Accumulation

The most direct effect of the bank is on accumulation of capital, both working and fixed. A Grameen Bank loan is repaid in small installments every week, so it is easy for a borrower to pay an installment from income, leaving capital intact. A Grameen

Table 28—Amount of loans received from various sources, by different groups of rural households, 1984/85

Household Category	Number of Loans	Noninstitutional Credit: Households Receiving Loans	Noninstitutional Credit: Average Loan Received per Household	Institutional Credit: Households Receiving Loans	Institutional Credit: Average Loan Received per Household
		(percent)	(Tk)	(percent)	(Tk)
A. Grameen Bank member	69	5.8	32	94.2	3,300
B. Nonparticipant within target group in project village	68	20.6	245	4.4	279
C. Grameen Bank target group in control village	63	17.5	298	1.6	16
D. Nontarget group	79	15.2	578	27.8	1,075
Total	279	14.7	345	30.1	1,192
Grameen Bank nonmember (groups B, C, and D)	210	17.6	448	9.0	500

Source: Household survey in project and control villages.

Table 29—Changes in working capital after joining Grameen Bank, by type of borrower, 1985

Type of Borrower	Number of Borrowers	Borrowers Reporting Working Capital: Before Membership	Borrowers Reporting Working Capital: At Time of Survey	Amount of Working Capital per Borrower at Current Prices: Before Membership	Amount of Working Capital per Borrower at Current Prices: At Time of Survey	Amount of Working Capital per Borrower at Current Prices: Increase per Year[a]
		(percent)	(percent)	(Tk)	(Tk)	(percent)
Sex						
Male	441	54.0	85.0	1,237	4,141	56
Female	534	41.9	79.4	336	1,713	88
Occupation						
Processing and manufacturing	245	70.2	95.1	908	3,544	67
Trading and shopkeeping	319	49.2	87.5	1,166	4,083	59
Other	411	32.4	69.8	316	1,386	75
Total	975	47.4	81.9	743	2,811	64

Source: Survey of 975 borrowers.

[a] Calculated on the basis of an average length of membership of 2.25 years, after adjusting for inflation of 10 percent a year.

Bank member is expected to have a larger amount of capital when taking a repeat loan than at the time of becoming a member. Also, since the bank provides a repeat loan in a relatively larger amount, it is possible for the borrower to divert some credit or incremental income for making medium- and long-term investments, such as the purchase of cattle or acquisition of machinery, tools, and equipment.

The change in the status of borrower households vis-à-vis working capital after joining the Grameen Bank will be seen from Table 29. Less than half the borrowers reported investment in working capital before they joined the bank. At the time of the 1985 borrower survey the number was 82 percent, indicating a vast increase in the proportion of households undertaking new enterprises. The average amount of working capital per borrower household increased nearly four times, from Tk 743 to Tk 2,811, within about 2.25 years. This period was the average length of bank membership for the sample borrower households. (See Table 20 for distribution of sample borrowers by length of membership.) Even after adjusting for inflation, which has been about 10 percent a year, the average increase comes to a substantial 64 percent a year. This increase has been even faster for female borrowers and for households engaged in services and manufacturing. For other activities, such as livestock raising, investment in fixed assets is probably more important than working capital.

The effect of the Grameen Bank on accumulation of capital can also be assessed by differentiating the sample borrowers according to length of membership with the bank and looking at their investment behavior (see Table 30). About 80 percent of households reported accumulation of nonagricultural capital after joining the bank, and the average amount of investment was higher for longtime borrowers than for newer ones. Fifty-four percent of households reported some investment in crop cultivation after joining the bank. This type of investment increased up to the third year of membership and was lower for longtime borrowers. The marginal accumulation in crop cultivation also declined sharply, even for borrowers of less than three years' standing.

For investments in housing, education, and sanitation, which are not directly productive but would promote human capital formation in the long run, both the average and the incremental investments increased with length of membership in the bank. It appears that in the initial years, when the

Table 30—Accumulation of capital after joining Grameen Bank, by length of membership and sex of borrower, 1985

Length of Membership/ Sex of Borrower	Number of Borrowers	Nonagricultural Investment[a]		Agricultural Investment[b]		Social Investment[c]	
		Members Reporting	Average Amount per Borrower	Members Reporting	Average Amount per Borrower	Members Reporting	Average Amount per Borrower
		(percent)	(Tk)	(percent)	(Tk)	(percent)	(Tk)
Less than one year	269	79.6	1,377	48.3	1,002	82.5	662
One to two years	372	86.6	2,597	61.3	1,923	89.2	989
Two to three years	164	77.4	2,968	56.7	2,259	83.5	1,656
Three years or more	170	65.9	3,751	42.9	1,926	71.2	3,541
All borrowers	975	79.5	2,524	53.6	1,726	83.3	1,456
Male	441	81.4	3,505	54.0	1,813	87.1	1,892
Female	534	77.9	1,714	53.4	1,654	80.1	1,096

Source: Survey of 975 borrowers.

[a] Includes expenditures on purchase of transport and industrial equipment, and additions to working capital in nonagricultural enterprises.

[b] Includes expenditures on purchase of cattle, agricultural equipment, and land.

[c] Includes expenditures on housing, education, and sanitation.

level of investment is low and hence the productivity of capital is high, the tendency is to accumulate more in productive lines. A decline in the rate of return with increases in the volume of capital,[62] however, induces longtime borrowers to move to social investments and conspicuous consumption. The expenditure on social and religious ceremony (not shown in the table) is estimated at Tk 928 and Tk 801 for first- and second-time borrowers, respectively, but Tk 2,180 and Tk 4,783 for third-time and longer borrowers.

Table 31 shows how successive Grameen Bank loans contribute to the increase in equity (own investment) capital according to the length of membership of the borrower household. Average investment from own funds increased from Tk 870 for first-time borrowers to more than Tk 5,700 for members who had borrowed four times or more. The share of equity in total invest-

Table 31—Effect of Grameen Bank on growth of equity capital, 1985

Length of Membership	Average Amount of Current Loan	Average Accumulation of Capital After Joining Bank		Average Share of Equity in Accumulated Capital
		Total	Equity	
	(Tk)	(Tk)		(percent)
Less than one year	2,181	3,041	870	28.3
One to two years	3,205	5,509	2,304	41.8
Two to three years	3,702	6,883	3,181	46.2
Three years or more	3,450	9,218	5,768	62.6

Source: Survey of 975 borrowers.

---

[62] This was found to be the case in an earlier evaluation of the Grameen Bank. See Hossain, *Credit for the Rural Poor,* p. 90.

ment increased from 28 percent for first-time borrowers to 63 percent for members borrowing four times or more.

An important asset for the rural poor is livestock. More than two-fifths of total loans disbursed by the Grameen Bank are now taken for livestock raising. Changes in the pattern of livestock ownership after Grameen Bank intervention are shown in Table 32, which compares the ownership pattern at the time of joining the bank (by processing information provided in the membership application form) with that at the time of the survey (from information reported by the sample borrowers). About 63 percent of households did not own any cattle at the time of joining the bank, but this figure had been reduced to 45 percent by the time of the survey. Also, a much larger proportion of households owned two or more cattle at the time of the survey than before joining the bank. The average number of cattle owned increased by about 67 percent during this period. The proportion of households owning goats, however, did not increase much, although the number of goats owned per household increased by about 18 percent.

Table 32—Changes in pattern of livestock ownership after intervention by Grameen Bank, 1985

Number of Animals Owned by Household	Ownership at Time of Joining Bank (N = 4,641)		Ownership at Time of Survey (N = 975)	
	Cattle	Goats	Cattle	Goats
	(percent of households)			
None	62.7	68.1	44.5	65.8
One	20.3	17.6	23.8	13.8
Two	12.0	9.1	21.8	11.0
Three	3.1	3.7	6.4	4.5
Four or more	1.9	1.5	3.5	4.7
Total	100.0	100.0	100.0	100.0[a]
	(number of animals)			
Average per 100 households	61	60	102	71

Sources: Grameen Bank membership application forms and the survey of 975 borrowers.
Note: N is the size of the sample.
[a] Parts do not add to total because of rounding.

Effect on Occupation and Employment

The main objective of the Grameen Bank is to create opportunities for a vast unutilized labor resource by extending credit facilities to poor men and women for self-employment activities. Any evaluation of the bank should thus quantify the extent to which this has been achieved. Two aspects of employment generation are highlighted here: generation of new employment for the previously unemployed and generation of additional employment for the underemployed.

The change in the principal occupation of borrowers as a result of Grameen Bank membership is shown in Table 33. About 31 percent of the borrowers reported themselves unemployed before joining the bank. Thus the bank helped to generate new employment for about one-fifth of its members. This new employment was generated mostly for female members, half of whom reported having no primary occupation before joining the bank; at the time of the survey this proportion had been reduced to 21 percent. Thus about one-third of the female members who had been unpaid domestic workers had become income earners. It is noteworthy that one-fifth of the female borrowers reported having no principal income-earning occupation at the time of the survey. Some of them may have taken a loan on behalf of the husband or the male head of household,[63] but some may have been engaged in livestock raising or cottage industry as part-time workers. About 44 percent of the sample female borrowers took credit for livestock

---

[63] R. I. Rahman found that 12 percent of female borrowers surrendered the entire loan amount to their husbands or male guardians, but 77 percent of them utilized more than three-fourths of the loan themselves. See Rushidan Islam Rahman, *Impact of Grameen Bank on the Situation of Poor Rural Women*, Grameen Bank Evaluation Project Working Paper 1 (Dhaka: Bangladesh Institute of Development Studies, 1986), pp. 32-35.

Table 33—Changes in occupation of borrowers after joining Grameen Bank, 1985

Principal Occupation	Before Joining Grameen Bank: Male (N = 441)	Female (N = 534)	All (N = 975)	At Time of Survey: Male (N = 441)	Female (N = 534)	All (N = 975)
	(percent of borrowers)					
Cultivation of family farm	7.3	0.4	3.5	6.3	0.4	3.1
Agricultural wage labor	20.0	1.9	10.1	2.1	0.2	1.0
Livestock and poultry raising	0.4	0.9	0.7	6.5	7.2	6.9
Processing and manufacturing	17.2	38.4	28.8	16.6	53.4	36.7
Trading and shopkeeping	32.2	5.4	17.5	46.3	15.9	29.6
Transport operations	5.9	0.2	2.7	9.5	0.4	4.9
Construction and other services	10.4	2.4	6.1	12.7	1.9	5.3
Unemployed	6.6	50.4	30.6	0.0	20.8	11.4
Total	100.0	100.0	100.0	100.0	100.0[a]	100.0[a]

Source: Survey of 975 borrowers.
Note: N is the size of the sample.
[a] Parts do not add to total because of rounding.

raising, but only 7 percent reported it as their principal occupation at the time of the survey.

Only 7 percent of male members reported being unemployed before joining the bank. For them, new employment was created mostly in livestock farming. For those already employed, there was a change in occupational pattern away from agricultural wage labor to petty trade. The proportion of male members who reported agricultural wage labor as their principal occupation was 20 percent before joining the bank but only 2 percent at the time of the survey, while the number of those who reported trading as their principal occupation increased from 32 to 46 percent during this period. The withdrawal of this significant proportion of Grameen Bank members from the agricultural labor market is expected to have an indirect positive effect on employment and earnings of the remaining agricultural wage laborers who did not join the bank.

The generation of new employment is also reflected in changes in the proportion of household members participating in income-earning activities. The in-depth household survey collected information about the composition of the households from which labor force participation rates (workers as a proportion of household members) have been estimated for the project and control groups (see Table 34). The average household size for the sample villages was estimated at 5.60 persons, which is comparable to 5.74 estimated by a 1981/82 national survey[64] for rural areas. The proportion of children up to age 14 was, however, lower in the sample villages (41 percent) than in the country as a whole (47 percent), as estimated by the 1981 population census.[65] The estimated labor force participation rate was 33 percent for the survey sample, compared with 30 percent for the entire country in the 1983/84 labor force survey.[66]

The comparison between Grameen Bank members and nonparticipants in the target group showed a statistically insignificant difference in household size and com-

---

[64] Bangladesh, Bureau of Statistics, *Report of the Bangladesh Household Expenditure Survey, 1981-82* (Dhaka: Ministry of Planning, 1986).

[65] Bangladesh, Bureau of Statistics, *Final Report of Bangladesh Population Census, 1981: Analytical Findings and National Tables* (Dhaka: Government Press, 1984).

[66] Bangladesh, *Labor Force Survey, 1983-84.*

Table 34—Labor force participation rates of members and nonparticipant groups, 1984/85

Variable	Member Households (N = 69)	Target-Group Nonparticipant Households		Nontarget Group Households (N = 79)	All Households (N = 279)
		Project Village (N = 68)	Control Village (N = 63)		
			(number of persons)		
Average size of household	5.14	4.90	5.03	7.06	5.60
Adults (age 15 +) per household					
Male	1.57	1.46	1.59	2.32	1.76
Female	1.41	1.37	1.33	2.06	1.57
Workers per household					
Male	1.59	1.40	1.43	2.00	1.62
Female	0.51	0.21	0.24	0.03	0.24
			(percent)		
Workers as percentage of all household members	40.9	32.9	33.2	28.8	33.2
Workers as percentage of adult household members	70.5	56.9	57.2	46.3	55.9
Female workers as percentage of female adults	36.2	15.3	18.0	1.5	15.3
Female workers as percentage of total workers	24.3	13.0	14.4	1.5	12.9

Source: Household survey in project and control villages.
Note: N is the size of the sample.

position. But the number of workers was higher for member households than for target-group nonparticipants in both project and control villages. Workers constituted 41 percent of all household members among bank participants, compared with 33 percent for nonparticipants in the same landholding group. The difference is, however, mostly due to female workers, who were 36 percent of adult females in the project group, compared with 15 to 18 percent in the control groups. The difference in the number of female workers between bank members and the control group is statistically significant at less than 5 percent probability. About 25 percent of the workers in member households were women, compared with 14 percent for nonparticipants in the target group and an almost insignificant 1.5 percent among nontarget-group households. The positive contribution of Grameen Bank in creating new employment for women, thereby reducing the dependency ratio in the households, is amply demonstrated by these figures.

The effect of Grameen Bank loans on reducing underemployment is difficult to quantify accurately without conducting a costly and time-consuming regular employment survey throughout the year. Instead, we asked respondents in the borrower survey to report their average number of days of employment per month and average number of hours worked per day in the occupation for which the loan was taken, both before they joined the bank and in the year of the survey. From this somewhat imprecise information it is possible to estimate standard eight-hour days of employment in the enterprise undertaken with the loan, which at least gives a qualitative indication of the change in underemployment as a result of Grameen Bank intervention (see Table 35).

Before joining the bank, an average worker in a member household was em-

Table 35—Increase in employment in activity for which loan was taken, by occupation and sex of borrowers, 1985

Occupation	Number of Members	Employment		Increase in Employment
		Before Membership	At Time of Survey	
		(eight-hour days/month)		
Crop cultivation	29	7.6	18.7	11.1
Livestock and poultry raising	319	3.4	16.7	13.3
Processing and manufacturing	245	10.8	22.0	11.2
Trading	274	4.7	16.0	11.3
Shopkeeping	45	8.6	18.5	9.9
Transport operations	43	4.9	20.3	15.4
Other	20	0.9	3.9	3.0
Total	975	6.0	18.0	12.0
Male	441	9.4	21.9	12.5
Female	534	3.3	15.0	11.7

Source: Survey of 975 borrowers.

ployed for about 6 standard days of work a month in the activity for which the loan was taken. At the time of the survey, such employment was estimated at 18 days. The Grameen Bank loans thus generated additional employment in that activity for about 12 days a month. Some of this additional employment may be due to reallocation of labor from other activities; for example, from agricultural wage labor for male workers and domestic labor for female workers. Adequate information is not available to quantify the extent of such reallocation. The additional employment generated in an activity was almost the same for male and female workers, although the average monthly employment for females was 7 days less than for males. Manufacturing and transport services were relatively more full-time occupations than trading and livestock raising. The additional employment generated was highest for transport services (15 days), but did not vary much for other occupations (10 to 15 days).

A separate survey of a subsample of 151 female borrowers and 241 other households covered in this study collected information on time allocation for one month by various members of the household to the activity organized by the female borrowers.[67] Female members worked an average of 4.9 hours a day (18 standard eight-hour working days a month), of which 4.2 hours (16 standard days a month) were spent in the loan-financed activity. In comparison, housewives in the target-group nonparticipant households spent 0.64 hours a day (2.4 standard days a month) in income-earning or expenditure-saving economic activities within the household, and housewives in nontarget-group households spent 0.55 hours a day (2.1 standard days a month) in these activities. This comparison suggests that the Grameen Bank loan helped to increase female employment by 16 standard eight-hour days a month. The survey also found that the activity undertaken by female borrowers provided employment to other members of the household for 2.6 hours a day per household, or about 10 standard eight-hour days a month.

Effect on Income

The findings reported in the previous section demonstrate that Grameen Bank credit has a positive effect on income. This section attempts to quantify this effect from direct information on income collected through the 1985 field surveys. However, accurate estimation of income is difficult, since the borrowers do not keep any records of their business. Thus the results may contain some margin of error.

---

[67] R. I. Rahman, *Impact of Grameen Bank*, pp. 17, 53.

Table 36 shows the borrowers' perception of the effect of Grameen Bank membership on their economic condition. Only 1.9 percent of them reported that their economic condition had deteriorated after joining the bank, and another 5.7 percent reported that there had been no improvement. Thus an overwhelming majority (91 percent) thought that the bank had made a positive contribution to their standard of living. This positive response was slightly higher for male borrowers than for females. The stated primary reason for the improvement was accumulation of capital, while additional employment in productive work and fruit and vegetable growing were given as the most important secondary reasons (see Table 37).

Table 36—Borrowers' perception of change in their economic condition after joining Grameen Bank, 1985

Economic Condition	Male Borrowers (N=441)	Female Borrowers (N=534)	All Borrowers (N=975)
	(percent)		
Improved	92.7	90.0	91.2
Unchanged	5.2	6.2	5.7
Deteriorated	1.4	2.2	1.9
No response	0.7	1.7	1.2
Total	100.0	100.0[a]	100.0

Source: Survey of 975 borrowers.

Note: N is the size of the sample.

[a] Parts do not add to total because of rounding.

The in-depth household survey in five project and two control villages collected detailed information on the gross value of output and the cost of production for different production and service activities in which the sample households were involved. Table 38 presents the estimates of income from this information for member households and for nonparticipant households within the target group in both project and control villages. The income effect of the Grameen Bank can be estimated by compar-

Table 37—Borrowers stated reasons for their improved economic condition after joining Grameen Bank, 1985

Reason	Primary Reason			Primary and Secondary Reasons[a]		
	Male	Female	Total	Male	Female	Total
	(percent)					
Free from clutches of *mohajons*[b]	12.4	5.3	8.6	33.3	13.5	22.9
Accumulation of capital	67.7	52.6	59.8	88.4	79.2	83.6
Additional employment in productive work	8.7	31.3	20.5	28.0	65.6	47.7
Increase in wage rate	1.0	1.4	1.2	7.8	11.4	9.7
More involvement in poultry raising	0.0	0.5	0.2	13.9	19.7	16.9
More involvement in vegetable and fruit growing	0.5	0.2	0.4	52.0	38.2	44.8
Additional investment in agriculture	2.8	1.4	2.0	27.3	14.2	20.4
Other	7.1	7.3	7.2	19.4	24.5	22.1
Total	100.0[c]	100.0	100.0[c]	270[c]	266[c]	268[c]

Source: Survey of 975 borrowers.

[a] Respondents were asked to report three factors behind the improvement in their condition, in order of importance. These columns show the distribution of all responses. The figures and the totals show that respondents reported, on average, 2.68 reasons.

[b] Professional moneylenders who are a primary source of informal, noninstitutional loans to the poor.

[c] Parts do not add to total because of rounding.

Table 38—Level and structure of household income for Grameen Bank members and comparable nonparticipant groups, 1984/85

Income Component	Grameen Bank Members (Group 1)	Target-Group Nonparticipants		Difference	
		Project Villages (Group 2)	Control Villages (Group 3)	Group 1 Over Group 2	Group 1 Over Group 3
		(Tk/household)		(percent)	
Agriculture	5,606	5,323	6,577	5.3	−14.8
Crop cultivation	2,782	2,199	2,312	26.5	20.3
Kitchen garden	512	305	567	67.9	−9.7
Livestock and fisheries	941	788	928	19.4	1.4
Agricultural wage labor	1,371	2,031	2,770	−32.5	−50.5
Nonagriculture	12,528	8,881	6,119	41.1	104.7
Processing and manufacturing	4,355	2,753	1,119	58.2	289.2
Trading	3,859	2,234	1,369	72.7	181.9
Transport operations	1,352	572	735	136.4	83.9
Nonagricultural wage labor	670	826	738	−18.9	−9.2
Other nonagricultural (earthwork and self-services)	2,292	2,496	2,158	−8.2	6.2
Household income	18,134	14,204	12,696	27.6	42.8
Per capita income	3,524	2,900	2,523	21.5	39.7

Source: Household survey in project and control villages.

ing the income of bank members with that for the other two groups.

The average household income for the bank members was about 43 percent higher than that for the target group in the control villages and about 28 percent higher than for the target-group nonparticipants in the project villages. The difference is statistically significant. The agricultural income, particularly income from cultivation of family farms, was broadly similar across the groups. The positive income effect was mainly due to large increases in income from processing and manufacturing, trading, and transport operations—activities financed by Grameen Bank loans. The total income from these three nonagricultural activities was about two times higher for bank members than for the target group in the control villages, and about three-fourths higher for members than for target-group nonparticipants in the project villages.

An important point shown in Table 38 is that income from wage labor and various self-services is substantially higher for nonparticipants (Tk 5,353 per household) than for bank members (Tk 4,333) within the project villages. This indicates that Grameen Bank contributes indirectly to the growth of income of nonparticipant households through some withdrawal of supply from the labor market on the part of members. In a study of the effect of the Grameen Bank on local power structures, Rahman interviewed 49 local leaders, and 43 of them complained that Grameen Bank activities had reduced the supply of agricultural laborers in the locality.[68] Based on their reports, it was estimated that the wage rate for agricultural laborers increased by 19 percent a year—from Tk 14.2 to Tk 24.5 a day within a three-year period. The increase was higher during the peak season (20 percent) than during the slack season (17 percent). For Bangladesh as a whole, the nominal agricultural wage rate increased by 16 percent a year during 1982-85, when the cost-of-living index increased by 10 percent a year. The

---

[68] Atiur Rahman, *Impact of Grameen Bank Intervention on Rural Power Structure*, Grameen Bank Evaluation Project Working Paper 2 (Dhaka: Bangladesh Institute of Development Studies, 1986).

Table 39—Annual household income in project and control villages, by landownership group, 1984/85

Landownership Group	Share of Households in Group	Project Village	Control Village	Difference in Project Over Control Villages
(acres)	(percent)	(Tk/household)		(percent)
None	10.5	10,256	8,090	26.8
0.01–0.49	42.5	16,381	14,553	12.6
0.50–2.49	31.0	20,349	20,809	–2.2
2.50–4.99	11.0	29,110	29,549	–1.5
5.00 or more	5.0	41,074	46,776	–12.2
All groups	100.0	19,603	16,970[a]	15.5

Source: Household survey in project and control villages.

[a] The pattern of landownership is somewhat different in the project and control villages. To make the comparison meaningful, the average household income for the control villages has been estimated as weighted average by multiplying the group-specific average income by the proportion of households in each group in the project village.

increase in the real wage rate was higher in the project area.

An important question at this point is whether Grameen Bank intervention leads to an overall increase in rural income or merely achieves a redistribution of income from the rich to the poor—and among the poor, from nonparticipant households to participants. Table 38 shows that the average household income for nonparticipants within the target group in the project villages is 12 percent higher than that for the target group in the control villages. This difference is contrary to what would be expected had there been a redistribution of income from nonparticipants to participants among the poor.

Table 39 compares the income of different landownership groups for the project and control villages. It appears from the figures that the positive income effect was highest for the absolutely landless, followed by the marginal landowners. But the income of the nontarget-group households was lower in the project villages than in the control villages, and the difference was larger for the upper landownership groups. This indicates some redistribution of income from large-landownership groups to the landless. The comparison between average household incomes in the project and control villages, however, indicates that income in project villages may have increased by about one-sixth as a result of intervention by the bank.

Alleviation of Poverty

The most commonly used measure of poverty is the "head-count ratio." It measures the proportion of households or populations whose income falls below a threshold (termed a poverty line) required for meeting basic food and nonfood needs. To estimate the poverty line, a balanced diet consisting of food items typically consumed in a country and capable of ensuring a certain level of calorie and protein intake is valued, using representative prices. The expenditure on nonbasic food needs is then taken into account to determine the income at which the minimum balanced diet can be ensured. This information is then applied to the distribution of population according to per capita income groups to estimate the population whose income falls below the poverty line.

The minimum energy and protein requirements for the average Bangladesh population, as recommended by various institutions, vary significantly. Several studies of rural poverty in Bangladesh used a consumption bundle providing an intake of 2,112 calories and 58 grams of protein,

Table 40—Estimates of proportion of poor population among participants and target-group nonparticipants, 1984/85

Variable	Grameen Bank Members	Target Group Nonparticipants Project Villages	Target Group Nonparticipants Control Villages	All Households Project Villages	All Households Control Villages
Gini concentration ratio of income	0.257	0.254	0.285	0.283	0.281
			(percent)		
Proportion of moderately poor population	61.0	83.7	80.4	61.5	76.3
Proportion of extremely poor population	48.0	76.0	74.4	47.1	54.6

Source: Estimated from the income distribution data obtained through the household survey in project and control villages.

which by and large conforms to the minimum diet recommended by the Food and Agriculture Organization of the United Nations.[69] At the retail prices prevailing in selected cities in 1984/85, the cost of the consumption bundle is valued at Tk 9.58 per capita per day. On the basis of the assumptions that rural prices are about 80 percent of the urban level and that 80 percent of the poverty-level income is spent on food, the poverty line is estimated at Tk 3,500 per capita per year. In order to identify the hardcore poor, a line of extreme poverty is drawn at Tk 2,975, which would satisfy 85 percent of the required calorie and protein needs.

The degree of inequality in distribution of income for the different groups of households under study and the proportion of poor population obtained from the income distribution data are reported in Table 40. The Gini concentration ratio is lower among Grameen Bank members than among the target group in control villages, but is almost the same among members and nonparticipants in project villages. There was, however, a much higher concentration of population in the lower-income brackets in both control groups than in member households. For example, households earning up to Tk 2,000 per capita (nearly two-thirds of the poverty-level income) contained almost 50 percent of the total population in both control groups, compared with only 19 percent among bank members.

Table 40 shows the proportion of population living in moderate poverty at 84 percent for target-group nonparticipants in project villages, 80 percent for the target group in control villages, but 61 percent for Grameen Bank members. Those living in extreme poverty were estimated at 48 percent for members, compared with about 75 percent for both control groups. These figures suggest that the bank has been able to lift a significant proportion of its members out of poverty.

The effect on alleviation of poverty is also felt at the village level. The relative inequality in distribution of income was similar in project and control villages, but the incidence of absolute poverty was much lower in project villages. The proportion of moderately poor population was 62 percent in project villages, compared with 76 percent in control villages.

Improvement in the standard of living of Grameen Bank participants is also suggested by a comparison of expenditures on food and nonfood basic needs for different groups of households (Table 41). The per capita expenditure on food for member households was 8 percent higher than for nonparticipants in project villages, and 35 percent higher than for the target group in control villages. The expenditure on cloth-

---

[69] Muqtada, "Poverty and Inequality," p. 59.

Table 41—Expenditures on basic needs by Grameen Bank members compared with control groups, 1984/85

				Difference of Project Over Control Groups	
Variable	Members	Nonparticipants in Project Villages	Target Group in Control Villages	Nonparticipants in Project Villages	Target Group in Control Villages
		(Tk/person)		(percent)	
Expenditure on food	1,965	1,823	1,456	8	35
Expenditure on cereals	1,287	1,271	1,044	1	23
Expenditure on noncereal food	578	552	412	5	40
Expenditure on clothing	170	151	129	13	32
		(Tk/household)			
Expenditure on education	156	152	105	3	49
Expenditure on health	225	210	170	7	32
Expenditure on housing	934	685	160	36	484
		(percent)			
Households incurring expenditures for education	43.5	32.4	31.7	34	37
Households incurring expenditures for housing	78.3	66.1	49.2	19	59

Source: Household survey in project and control villages.

ing for members was 13 percent higher than for nonparticipants in project villages and 32 percent higher than for the target group in control villages. The proportion of households that incurred expenses for children's education and housing improvement was larger for members than for the control groups. The investment in housing by members was about six times higher than that of the target group in control villages and about one-third higher than that of the target-group nonparticipants in project villages. Thus, the bank's emphasis on sustained improvement in the standard of living of its clientele through the social development program (see "Sixteen Decisions" in Chapter 4) seems to be supported by action on the part of its members.

8

COSTS OF OPERATION

Contrary to the conventional banking practice that the borrower comes to the bank to receive and repay a loan, the Grameen Bank goes to its clientele for both disbursement of loans and collection of repayments. The loans are small and repayments are collected in weekly installments. In addition, the bank takes the responsibility of giving its clientele intensive training in credit discipline and engages in a social development program. All this means that the paperwork and the staff time needed for servicing a given amount of loan are higher than for a normal rural credit program. The benefits of this intensive credit program, in the form of excellent recovery of loans and significant improvement of the economic condition of the extreme poor, need to be evaluated against the high costs of operation.

The annual reports of the Grameen Bank for 1984-86 state that the bank operates at a marginal profit. A close scrutiny of the accounts, however, shows that the credit operations of the bank involve losses that are compensated for by profits from deposits in other banks of a substantial amount of low-cost funds available from international donors.

Sources and Costs of Funds

The major sources of funds for the Grameen Bank are borrowings from the Bangladesh Bank and loans and grants from the International Fund for Agricultural Development (IFAD). A small amount is also available as loans from the Netherlands and the Ford Foundation. The Grameen Bank also draws on the deposits contributed by members to the Group Fund, the Emergency Fund, and special savings funds. In 1985 the bank started experimenting with deposit-banking at 25 branches, accepting deposits from all rural households, but these deposits still constitute an insignificant proportion of the funds. In 1986, deposits of nonmember households amounted to Tk 3.7 million—only 3 percent of the total deposited by members in the Group Fund.

Funds borrowed from the Bangladesh Bank under its refinancing scheme bear an interest rate of 8.5 percent a year and are repayable in 10 equal quarterly installments from the date of the loan. The Grameen Bank also borrows from the Bangladesh Bank under its rural housing financing scheme at an interest rate of 3.0 percent a year, repayable within 15 years on a quarterly installment basis. Two loans from IFAD have been obtained under two separate agreements between the Grameen Bank and the government of Bangladesh. The first loan is repayable in 15 years, beginning in March 1991, and bears an interest rate of 3.0 percent a year. The second loan, sanctioned in 1985, is repayable in 20 installments beginning in March 1995 at 2.0 percent annual interest. Financial accommodation through a temporary overdraft arrangement is available from a commercial bank at 16 percent a year. The Grameen Bank pays 8.5 percent annual interest on deposits, including the unutilized portion of the Group Fund.

Because of the widely varying rates of interest, the cost of Grameen Bank funds depends on the relative share of the various sources. The composition of the sources of funds and its change over the 1984-86 period is shown in Table 42. In 1986 the paid-up capital was only about 4 percent of the total liability of the bank, while borrowings accounted for 80 percent and deposits another 16 percent of the total liability. In 1985, borrowings from the IFAD loan accounted for 33 percent of total funds, and borrowings from the Bangladesh Bank were another 38 percent. In 1986, borrowings

Table 42—Shares of Grameen Bank funds from various sources, 1984-86

Source	1984		1985		1986	
	Amount Obtained	Share of Total Fund	Amount Obtained	Share of Total Fund	Amount Obtained	Share of Total Fund
	(Tk million)	(percent)	(Tk million)	(percent)	(Tk million)	(percent)
Borrowings	311.3	82.6	433.9	79.5	716.8	79.6
Bangladesh Bank	154.6	41.0	206.6	37.8	80.8	9.0
International Fund for Agricultural Development	139.5	37.0	180.1	33.0	587.6	65.3
Other[a]	17.2	4.6	47.2	8.7	48.4	5.4
Deposits	38.3	10.2	79.8	14.6	145.0	16.1
Group Fund	24.5	6.5	48.7	8.9	81.9	9.1
Emergency Fund	6.4	1.7	12.6	2.3	22.0	2.4
Other	7.4	2.0	18.5	3.4	41.1	4.6
Paid-up capital	25.2	6.7	30.0	5.5	35.5	3.9
Reserves	1.6	0.4	2.3	0.4	2.7	0.3
Total	376.7[b]	100.0[b]	546.0	100.0	900.0	100.0[b]

Sources: Grameen Bank, *Annual Report*, 1984, 1985, 1986 (Dhaka: Grameen Bank, 1985, 1986, 1987).
Note: n.a. means not available.
[a] Includes drawings from a loan from the Netherlands.
[b] Parts do not add to total because of rounding.

from the Bangladesh Bank declined substantially to only 9 percent of total funds, while the share of the IFAD loan increased to 65 percent. The share of deposits increased from 10 percent in 1984 to 16 percent in 1986, mainly because of increased accumulation in the Group Fund and Emergency Fund.

The estimated cost of Grameen Bank funds is reported in Table 43. As expected, the Bangladesh Bank is the highest-cost source, while IFAD is the lowest. In 1985 the average cost of funds was 5.8 percent, but the average came down to 3.6 percent in 1986, largely because of increased drawings from the IFAD loan. The interest payment on the IFAD loan in 1986 was about 66 percent higher than in the previous year, while the interest paid to the Bangladesh Bank declined by 36 percent in 1986. The total liability of the Grameen Bank in 1986 was 65 percent higher than in 1985, while the interest payment increased by only 4.7 percent in 1986.

Table 43—Changes in cost of Grameen Bank funds, 1984-86

Source	Amount of Interest Paid			Effective Cost of Funds		
	1984	1985	1986	1984	1985	1986
	(Tk million)			(percent)		
Borrowings	14.12	25.54[a]	23.55	5.1	5.9	3.3
Bangladesh Bank	11.16	18.30	11.68	7.2	8.9	n.a.
International Fund for Agricultural Development	2.32	5.32	8.84	1.7	3.0	n.a.
Other	0.64	1.91	3.03	3.7	4.1	n.a.
Deposits	1.84	4.09	7.47	4.8	5.1	5.2
Total	15.96	29.63	31.02	4.6	5.8	3.6

Sources: Grameen Bank, *Annual Report*, 1984, 1985, 1986 (Dhaka: Grameen Bank, 1985, 1986, 1987).
Note: n.a. means not available.
[a] Parts do not add to total because of rounding.

Table 44—Trends in use of Grameen Bank funds, 1984-86

Item	Amount			Share of Total Property and Assets			Incremental Funds in 1986 over 1985	
	1984	1985	1986	1984	1985	1986	Amount	Share of Total
	(Tk million)			(percent)			(Tk million)	(percent)
Cash balance[a]	20.0	19.1	19.4	5.3	3.5	2.2	0.3	0.1
Loans and advances[b]	177.5	246.1	331.7	47.1	45.1	36.9	85.6	24.2
Fixed- and short-term deposits	146.5	218.5	435.5	38.9	40.0	48.4	217.0	61.3
Fixed and other assets[c]	32.7	62.3	113.3	8.7	11.4	12.6	51.0	14.4
Total property and assets	376.7	546.0	900.0[d]	100.0	100.0	100.0[d]	354.0[d]	100.0

Sources: Grameen Bank, *Annual Report*, 1984, 1985, 1986 (Dhaka: Grameen Bank, 1985, 1986, 1987).
[a] A large part of the cash balance was in short-term deposit accounts with other banks.
[b] Includes loans given for house-building purposes.
[c] "Other assets" includes interest accrued on the loans but not yet recovered.
[d] Parts do not add to total because of rounding.

Use of Funds and Income

The Grameen Bank operates to mobilize the poor from households with less than 0.5 acre of land and provide loans to them to improve their living standard. All of the bank's work centers around this activity and the staff are recruited for this purpose. The bank earns 16 percent interest annually on the total amount of outstanding loans with members, which is normally about 50 percent of the amount of loans disbursed to members during the year. The bank also provides housing loans up to Tk 18,000, which are recovered in weekly installments for periods of up to 10 years. Housing loans bear an interest rate of 5.0 percent a year. The income from housing loans, however, is insignificant. By the end of 1986, the cumulative amount disbursed for housing was only Tk 27 million—about 1.8 percent of the amount of normal loans. The actual amount of interest received on loan operations was 13.2 percent of the amount of loans in 1986—lower than in 1985 (14.4 percent).

As shown in Tables 44 and 45, a major source of Grameen Bank's income is from investment of a substantial part of available funds in fixed- and short-term deposits with other banks. This has become a highly profitable line of business, since the funds are available at very low cost (particularly from the IFAD loan), while fixed-term deposits

Table 45—Sources and composition of Grameen Bank income, 1984-86

Source of Income	Amount			Share of Total Income		
	1984	1985	1986	1984	1985	1986
	(Tk million)			(percent)		
Interest on loans and advances	23.39	35.55	43.91	66.1	54.1	48.8
Interest on fixed- and short-term deposits	11.90	29.77	45.68	33.6	45.3	50.8
Interest on government treasury bills	0.09	0.36	0.31	0.3	0.6	0.4
Total	35.38	65.69[a]	89.90	100.0	100.0	100.0

Sources: Grameen Bank, *Annual Report*, 1984, 1985, 1986 (Dhaka: Grameen Bank, 1985, 1986, 1987).
[a] Parts do not add to total because of rounding.

Table 46—Trends in cost of administration of loan operations, 1984-86

Item	Total Expenses			Expenses as Share of Total Liability			Expenses as Share of Amount of Loans		
	1984	1985	1986	1984	1985	1986	1984	1985	1986
	(Tk million)			(percent)			(percent)		
Salary and allowances	9.43	25.53	43.76	2.5	4.7	4.9	5.3	10.4	13.2
Other expenses	4.53	8.44	13.67	1.2	1.6	1.5	2.6	3.4	4.1
Depreciation	0.71	1.08	1.44	0.2	0.2	0.2	0.4	0.4	0.4
Provision for bad debt	0.50	0.60	1.10	0.1	0.1	0.1	0.3	0.2	0.3
Total	15.17	35.65	59.96[a]	4.0	6.5[a]	6.7	8.6	14.5[a]	18.1[a]

Sources: Grameen Bank, *Annual Report,* 1984, 1985, 1986 (Dhaka: Grameen Bank, 1985, 1986, 1987).
[a] Parts do not add to total because of rounding.

earn interest of 14.0 percent a year and short-term deposits, 8.5 percent. Very little staff time is needed for these financial transactions. In 1986 these deposits accounted for 48 percent of total property and assets—an increase from 39 percent in 1984. The interest earned on the deposits increased by nearly three times during 1984-86, while the interest earned on loans and advances to Grameen Bank members increased by 88 percent in this period. In 1984 the interest on these deposits accounted for about one-third of the income of the bank. By 1986 almost half of the bank's income came from this source.

In 1986 the incremental fund was Tk 354 million more than in 1985 (80 percent was obtained through additional borrowing, and 18 percent through additional deposits). Only 24 percent of the incremental fund was used for loans and advances, compared with 61 percent for additional investment in fixed- and short-term deposits and 14 percent for accumulation of assets (Table 44).

Cost of Administration

The extent and trends of operating expenses of Grameen Bank (excluding the cost of funds) are shown in Table 46. The major expenses are the salary and allowances of the staff (73 percent in 1986) and these have increased at a faster rate than other expenses. The bank makes very little provision for bad debt, which is based on an estimate of the actual amount of loans and advances remaining unrealized after a certain (unspecified) period of time. In 1986 the costs of operation stood at 6.7 percent of the total amount of funds. The incremental cost in 1986 over 1985 was 6.9 percent of the incremental fund handled by the bank.

Because the bank's activity centers around the mobilization of the poor and the administration of loans to them, the cost of its operation should be related to the amount of loans and advances rather than to total funds handled by the bank. This is shown in Table 46. In 1986 the costs of operation stood at 18.1 percent of the amount of loans and advances—a figure that must be regarded as very high. With the expansion of the bank, the costs of operation have increased rapidly (8.6 percent in 1984 and 14.5 percent in 1985), mostly because of increases in salary and allowances, which were only 5.3 percent of the amount of loans and advances in 1984, but nearly doubled to 10.4 percent in 1985 and further to 13.2 percent in 1986. The large increase in staff costs in 1985 was due to salary increases for government officials that were effective from June 1, 1985. The increase in staff costs continued in 1986 because the higher salaries were paid for only seven months in 1985, but for the full year in 1986. The magnitude of staff costs at the present level of salaries is thus reflected by the 1986 figures.

It should, however, be recognized that during this expansion phase the costs of operation are expected to be high because of the large number of new branches opening every year. In 1985 the bank opened

Table 47—Unit costs of operation of bank branches, by age of branch, 1984/85

Age of Branch	Salary and Allowances	Other Expenses	Total Expenses	Amount of Loans Outstanding with Borrowers[a]	Expenses as Share of Outstanding Loans
	(Tk thousand)				(percent)
Up to 6 months	30.8	9.6	40.4	165	24.5
6 months to 1.0 year	46.0	13.0	59.0	365	16.2
1.0–1.5 years	72.8	15.8	88.6	1,041	8.5
1.5–2.0 years	87.8	17.8	105.6	1,576	6.7
2.0–2.5 years	94.0	19.6	113.6	2,015	5.6
2.5–3.0 years	100.8	18.8	119.6	2,198	5.4
More than 3.0 years	107.6	20.8	128.4	2,259	5.7

Source: Compiled from unpublished information sent by the branches to the head office of Grameen Bank.

[a] The figures are averages for the beginning and the end of the year, except for the first two age categories, for which the figures refer to the end of the period.

74 new branches—nearly half of the number in operation at the end of 1984. In 1986 another 69 branches were added. The new branches take some time to reach full operation but have a fixed start-up cost. For older branches the costs of operation may be lower, as these branches should be able to expand their business without adding much to the fixed cost.

In order to see the extent to which the bank branches reap economies of scale with age, detailed information was obtained on costs of operation and amount of business for each branch for the six-month period from January to June 1985 and processed according to the age of the branches. The results are shown in Table 47. The six-month figures are multiplied by two in order to get an estimate for fiscal year 1984/85. The number of outstanding loans with borrowers increases rapidly with the age of the branch, but for branches more than two years old the increase in the amount lent is only marginal. The data indicate that a branch reaches maturity after about two years, when it handles, on average, outstanding loans of about Tk 2 million. The older branches may not have much underutilized capacity to increase business by expanding the coverage of members, although a vertical expansion is possible by increasing the average size of individual loans or increasing the number of loans for collective enterprises. At 1984/85 prices the operating costs of branches more than two years old were about 5.6 percent of the amount of outstanding loans, compared with more than 16.0 percent for branches from six months to one year old. Assuming a 100 percent salary increase effective June 1, 1985, and an unchanged amount of business, the costs of operation in 1986 for branches more than two years old would be roughly 9.3 percent, compared with 27 percent for branches from six months to one year old and 18.0 percent for all branches and higher-level supervisory offices. Thus nearly half of the existing cost of administration may be due to start-up costs.

Profitability and Implications for Subsidy

The profit-and-loss account of the Grameen Bank is summarized in Table 48. In 1984 the bank operated at a profit amounting to about 2.8 percent of the volume of loans and advances, but in 1985 and 1986 it just broke even.[70]

---

[70] The small negative profit for 1986 shown in Table 48 does not appear in the provisional profit-and-loss account of the bank in its 1986 *Annual Report*. This is because of the provision of Tk 1.1 million in loan losses (bad debt), which is taken out of the expenditure account and shown in the balance sheet, where the amount of loans and advances is the reported net of the bad debt.

Table 48—Profit-and-loss accounts, 1984-86

Item	Amount			As Share of Loans and Advances		
	1984	1985	1986	1984	1985	1986
		(Tk million)			(percent)	
Income	35.38	65.69	89.90	19.9	26.7	27.1
Loan operation	23.39	35.56	43.91	13.2	14.5	13.2
Other operations (investments in fixed- and short-term deposits)	11.99	30.13	45.99	6.8	12.2	13.9
Expenditures	31.13	65.27	90.99	17.5	26.5	27.4
Cost of funds for loan operation	8.10	14.19	11.94	4.6	5.7	3.6
Cost of funds for other operations	7.86	15.43	19.09	4.4	6.3	5.8
Cost of administration of loan operation	15.17	35.65	59.96	8.6	14.5	18.1
Profits	4.90	0.46	−0.75	2.8	0.2	−0.2
Loan operation	0.12	−14.28	−27.99	0.1	−5.8	−8.4
Other operations	4.13	14.70	26.90	2.3	6.0	8.1
Sundry income	0.65	0.05	0.34	0.4	. . .	0.1

Sources: Compiled from Grameen Bank, *Annual Report,* 1984, 1985, 1986 (Dhaka: Grameen Bank, 1985, 1986, 1987).

During 1985 and 1986 the margin of profit was eliminated because of the large increase in salary and allowances. However, the bank incurs substantial losses on account of loan operations that are made up by profits from the deposit of loanable funds in other banks.

In 1986 the average cost of funds was 3.6 percent, while the income from fixed- and short-term deposits was 10.6 percent of the amount deposited on these accounts (Tables 44 and 48) and 13.9 percent of the loans and advances. Thus the bank was able to make a profit on this financial transaction to the extent of about 7.0 percent of the amount used for this purpose. The profit on this account was about 10.3 percent of the amount of loans and advances made to bank members. The large profit was made possible by the bank's access to low-cost credit available from the IFAD loan at only 2.0-3.0 percent a year. But even if the Grameen Bank had drawn on the funds from the Bangladesh Bank and the deposits in the Group Fund and other funds, it could have made some profit on this financial transaction, since the cost of funds from those sources is 8.5 percent a year.

The cost of the Grameen Bank's loan operation is substantially higher than the 16.0 percent rate of interest it charges on the loans. In 1986 the cost of administration was 18.1 percent of the total amount of loans, which together with the 3.6 percent cost of funds puts the total costs of operation at 21.7 percent. If the low-cost IFAD loan had not been available, the funds would have cost 8.5 percent and the costs of operation would have been about 26.6 percent. Even if the bank could reduce its cost of administration to 9.3 percent a year, as shown by the experience of branches that are more than two years old, the 8.5 percent cost of funds and an assumed 2.5 percent for overhead expenses (for supervision by area, zone, and head offices) would make the operating costs about 20.3 percent.

The Grameen Bank thus needs a subsidy for its operations. In 1986 the cost of loan operations was Tk 71.9 million (Table 48) while the income from loans and advances was 43.9 million, implying a subsidy rate of about 39 percent. If the funds had to be borrowed at 8.5 percent a year, the costs of operation would come to Tk 89.8 million, and the subsidy to 51 percent. The bank has so far managed on its own by drawing on the IFAD loan in excess of its actual needs for loans and advances. If this situation were to change adversely for the bank, it would become difficult to break even, and the bank would have to seek a direct subsidy from the government or increase the rate of interest charged to the borrower.

9

CONCLUSIONS AND LESSONS OF EXPERIENCE

It is clear from this study that the Grameen Bank has made a positive contribution to the alleviation of poverty in the area of its operation. The bank has successfully reached its target group with credit, and has ensured both productive utilization of loans and their recovery in due time, thus helping to improve the living standard of more than 90 percent of the participants. But the bank has so far covered only about 13 percent of the target group in the districts under its operation and 4 percent of the target group throughout Bangladesh. The question remains as to whether the bank can be extended widely enough to have a significant effect on the alleviation of poverty nationally, and whether the model can be replicated in other countries.

Constraints to Expansion

An important factor in determining the successful expansion of the Grameen Bank from the supply side is institutionalization of management so that it no longer depends on the personal leadership of the bank's founder-managing director. Since 1983 the bank has made good progress toward that end. Initially, the managing director participated in the recruitment and training of all bank workers and directly supervised their activities. With the expansion of the bank, a decentralization of administration has taken place, with responsibilities and decisionmaking power vested in a dedicated cadre of midlevel officers who were developed during the 1976-82 period of experimentation with the project. Incentives for hard work have been maintained through quick promotions and transfers based on performance in the field. Borrowers' representatives, center managers, and bank officials meet frequently in regional workshops to discuss important issues pertaining to the operation of the bank and the lives of the borrowers. Senior management personnel attend these workshops to keep constantly in touch with problems in the field, and the lessons learned are often translated into policy changes. Mainly owing to the decentralization of administration and to flexible and responsive management, the Grameen Bank has been able to confine its services to its target group and ensure excellent recovery of loans in spite of the large expansion that has taken place since 1983.

Another factor on the supply side is whether the Grameen Bank can provide its intensive services without depending on subsidies from outside sources. In spite of opening a large number of new branches, the bank just broke even during 1985 and 1986 at the 16 percent rate of interest it charges on loans. This was possible, however, because of substantial profits earned by keeping part of its low-cost loanable funds (obtained from an IFAD loan) in fixed- and short-term deposits with other banks, which cannot be a long-term source of income. The actual loss on the credit operation in 1986 was 5.7 percent of the outstanding loans, and at the imputed cost of the loan funds at which other financial institutions borrow (8.5 percent a year), the loss would have been about 10.0 percent. The loss is largely due to the pressure of higher salaries and inflation on the cost, a situation that may continue. The increase in income would not be high enough to cover the rising cost because of the Tk 5,000 limit on individual loans. The amount of outstanding loans with the borrowers of an average branch reaches Tk 2 million within a period of two years but increases very little thereafter. Considering the Grameen Bank's effect on poverty alleviation, the government may decide to provide a direct subsidy to the bank, but with the bank's rapid expansion the subsidy might be a burden to the government budget.[71] It appears that the bank may have to consider some policy changes for rapid expansion of its operation.

First, the Grameen Bank might increase the 16 percent annual interest charged on loans. This could be done, without increasing the borrower's transaction cost, by reducing the proportion of the loan that has to be deposited in the Group Fund. The Group Fund is a sore point with borrowers, as they cannot reclaim the money when they leave the group. The fund imposes an additional effective rate of interest of about 10 percent of the principal outstanding with the borrower for a year. Also, only about one-sixth of the Group Fund is actually used for the purpose for which the fund was created. If the contribution to the fund were reduced from 5 percent of the loan to 2 percent, the rate of interest could be increased from 16 to 22 percent without increasing the effective transaction cost of the loan to the borrower. In this case, the increase in the nominal rate of interest should not reduce the demand for loans.

Another consideration should be an annual upward revision of the maximum limit for an individual loan, at least in line with the rate of inflation. This would increase the amount of business and the income of the older branches.

The bank might also require repeat borrowers to make repayment in monthly or even quarterly installments, which would reduce the paperwork and the cost of operation. Those who have increased their income sufficiently might be allowed to graduate and seek credit from other banks. Longtime borrowers do not pay weekly installments on a regular basis, in any case, but they do make repayment within one year.

To increase the amount of business per branch, the bank could extend its credit operations to small farmers to provide short- and medium-term agricultural loans. Such loans might be repaid in seasonal installments collected immediately after harvest. Economies of scale could also be realized by providing more loans for collective enterprises.

Finally, if the rate of interest on the loans were raised, the Grameen Bank could profitably move into savings mobilization by accepting deposits at rates of interest similar to those paid by other banks. Grameen Bank branches are generally located in more interior areas of Bangladesh than are branches of commercial banks and hence can attract more customers. The Grameen Bank could also promote deposits from its target group, who are shy about depositing the small amounts they save in commercial banks. These deposits could form an important source of loanable funds for future expansion of the bank.

From the demand side, a major constraint to expansion of the bank could be the small size of the market for nonfarm goods and services financed with Grameen Bank loans. It can be argued that Grameen Bank borrowers have not yet faced this problem because the bank is still operating within a small area, and hence the members can count on markets outside the locality. With expansion of Grameen Bank operations, the competition among nonfarm producers would increase and the members would need to count more and more on their own local markets, which might lead to lower prices and lower productivity of self-exploitation of labor. It is true that at the present low level of income, the market served by Grameen Bank borrowers is small. But from the dynamic point of view, the size of the market may not pose a serious problem for expansion (for further elaboration see the Appendix). As agricultural income increases through technological progress, the market for nonfarm goods and services increases more than proportionately.[72]

The Grameen Bank target group comprises about half of the national population, and as their income rises they will demand one another's products and services, thus mutually expanding the market. The demand for food induced by the growth in nonfarm income, unlike demand from growth in agricultural income, is met by production outside the family, thereby stimulating demand for trading and transport services. To the extent that excess production capacity exists in other sectors and capacity utilization is constrained by the lack of effective demand and by underdeveloped trading and transport services, the alleviation of poverty and the development of petty trade could stimulate the growth of production in other sectors, leading to a second round of expansion in the market for nonfarm goods and services. Also, many of the products that the Grameen Bank finances, such as livestock, handloom products, wood and bamboo furniture, and fixtures (carpentry), have strong markets both within the country and abroad.

---

[71] The deficit in 1986 was Tk 28 million, amounting to 2.5 percent of the allocation to rural development activities in the annual development program for 1985/86.

[72] Mellor and Lele, "Growth Linkages," pp. 35-55; and Hossain, "Agricultural Growth Linkages," pp. 1-30.

The vertical expansion of the bank may be constrained by the low level of productivity in many activities that the bank's credit finances. This is known to be a particularly serious problem for the cottage industry sector, which receives about one-fourth of Grameen Bank loans.[73] It was observed in a previous study that with every repeat loan, the size of the loan increases, but the income increases at a much smaller rate because the rate of utilization of the loan for capital accumulation declines and the rate of return on capital also falls.[74] The same indication is obtained in the present study by the finding that longtime Grameen Bank members spend proportionately less on nonagricultural investment (relative to social investment) than do new members.

The bank management is aware of this problem, and to circumvent it the bank encourages members to take loans for collective enterprises so that they can reap economies of scale in business and can jointly own improved technology, thereby increasing labor productivity. But the success of the bank in this field has been limited. The collective enterprises have faced severe management problems, and widespread failures have put pressure on solidarity among members in many groups and centers. This has led Grameen Bank management to change its policy regarding the undertaking of collective enterprises. The bank now takes direct responsibility for initial management of the enterprises through joint ownership with the borrowers, and plans to hand over the management and full ownership after completion of a learning period by the borrowers. It is too early to evaluate the effect of this policy change. Another factor behind the widespread failure of collective enterprises may have been adherence to the same loan repayment procedure as that for individual loans (weekly repayment over a period of one year), which does not suit the financing of these relatively long-term fixed investments. To induce organization of collective enterprises, the bank may have to consider disbursing long-term credit and recovering it in seasonal (for agricultural investment) or annual installments.

Lessons of Experience

In 1984, in a study prepared for an IFAD midterm evaluation of the Grameen Bank, Dharam Ghai pointed out a number of lessons that can be learned from the bank's experience in planning and implementing development activities.[75] At that time the bank operated 89 branches and covered 70,000 members. It now operates more than 300 branches and has mobilized more than 250,000 households. But Ghai's observations are still valid today.

---

[73] For evidence of low productivity of a large number of cottage industries, see Mahabub Hossain, "Productivity and Profitability in Bangladesh Rural Industries," *The Bangladesh Development Studies* 12 (March-June 1984): 127-161; and Hossain, *Credit for the Rural Poor,* pp. 77-94.

[74] Hossain, *Credit for the Rural Poor,* pp. 90-92.

[75] Dharam Ghai, *An Evaluation of the Impact of the Grameen Bank Project* (Dhaka: Grameen Bank, 1984).

The Grameen Bank experience shows the vital importance of credit as an entry point for a program of social and economic development. If a program is to have an appeal for people living in abject poverty, it must offer them clear and immediate prospects for economic improvement. It is easy to sell other interventions for social development, however unconventional they may appear (as demonstrated by the acceptance of physical training and parades by traditional Muslim women), once improvements in standards of living are demonstrated. The bank has also shown that it is possible to devise projects that directly benefit the extreme poor.

The Grameen Bank experience also brings out the importance of appropriate training and orientation of the field staff for successful accomplishment of a project. The key to the success of the Grameen Bank is the orientation, approach, and human qualities inculcated in the bank workers through a training program based largely on "learning by doing," that is, through observation of and participation in the ongoing activities. Before they start work on their own, prospective staff are required to observe critically the workings of the rural economy and society and the plight of the rural poor. This helps them to understand the philosophy and approach of the bank and to develop qualities required for inspiring trust and confidence in the target group. The bank workers have demonstrated that under appropriate conditions, the idealism and energy of youth can be harnessed to combat poverty and underdevelopment.

The bank has clearly demonstrated that lack of collateral should not stand in the way of providing credit to the poor. The poor can utilize loans and repay them if effective procedures for bank transactions with them can be established. These procedures may differ according to the socioeconomic environment. In the Bangladesh context, formation of groups with a small number of like-minded people has worked well, and group solidarity and peer pressure have substituted for collateral. Other innovations of the bank are taking the bank to the people, rather than people to the bank; recovering loans in small weekly installments; and developing collective funds with compulsory savings from individuals for their mutual benefit.

The recent literature on rural financial markets emphasizes that the widespread failure of the rural credit program to achieve its objectives is attributable to following a low-interest-rate policy.[76] This policy led to rationing of credit, which benefited the upper-income groups and nonagricultural sectors because of their access to administrators, while it adversely affected mobilization of savings. The Grameen Bank experience shows that high-cost credit can keep the influential nontarget group away from a targeted credit program, but more importantly, it demonstrates the need to develop appropriate institutions for the delivery of loans.[77] Even a high-interest-rate credit program could fail because of corruption and mishandling of funds by bank staff, while an institution like the Grameen Bank is capable of successfully implementing a highly subsidized low-interest-rate credit program.

Replicability in Other Countries

The Grameen Bank is an innovative credit program and has attracted the attention of a large number of countries and international donors.[78] It has been visited by high-level government officials from Nepal, Malaysia, the Philippines, Indonesia, and the Solomon

---

[76] For a survey of the literature, see Adams and Vogel, "Rural Financial Markets"; and Avishay Braverman and J. Luis Guasch, "Rural Credit Markets and Institutions in Developing Countries: Lessons of Policy Analysis from Practice and Modern Theory," *World Development* 14 (No. 10/11, 1986): 1253-1267.

[77] The Grameen Bank experience supports the contention of Braverman and Guasch that a systematic and rigorous analysis of institutions and institutional environments is essential for understanding and implementing effective policy reforms of rural credit markets. Braverman and Guasch, "Rural Credit Markets," p. 1253.

[78] Mohammad Yunus, "The Grameen Bank: As I See It," International Labour Organisation, Geneva, November 1986 (mimeographed).

Islands, and by nongovernmental organizations and interested individuals from Kenya, Tanzania, and Rwanda. The Economic and Social Commission for Asia and the Pacific (ESCAP) organized a "Study Tour of Grameen Bank" for government representatives, bankers, and female program leaders of the region. IFAD is trying to launch a Grameen Bank-type credit program in Malawi. Malaysia has already formulated a project to experiment with such credit for the poor in Selangor State. Thus there is widespread interest in trying the Grameen Bank approach to credit in other countries. But will it work?

The Grameen Bank concept of generating self-employment through credit should work in countries with widespread poverty and underemployment. As long as there is surplus labor with little opportunity cost (under extreme poverty, leisure has little value), and labor can be transformed into salable commodities and services with a small amount of capital, there should be demand for Grameen Bank-type loans. And if the need for credit is genuine, and the transaction cost is such that it can be profitably used to increase household income, recovery of loans should not be a problem.

But it may not be possible to replicate universally the entire Grameen Bank approach to delivery of credit. Some elements of this approach, like formation of small homogeneous groups for group guarantee of loans and supervision of loan utilization, recovery of loans in small regular installments, and institutions for collective savings, could work well across different environments, but elements like taking the bank to the people and intensive interaction of bank staff with borrowers may not be appropriate and could become too costly for sparsely settled environments. The Grameen Bank approach has a fair chance of success in densely settled, poverty-stricken areas of Asia, but for Africa an appropriate delivery mechanism has to be worked out through trial and error. An approach or method cannot be replicated in a fixed, prescriptionary sense. Indeed, one of the important lessons of the Grameen Bank is that appropriate procedures can be developed only after considerable experimentation, through a thorough understanding of the physical and socioeconomic environment.

APPENDIX: EXPENDITURE PATTERNS AND THE MARKET FOR NONFARM GOODS AND SERVICES

The Grameen Bank finances mostly small, nonfarm enterprises conducted on a self-employment basis. One of the issues that affects successful expansion of the bank is the nature of the market for nonfarm goods and services.

In Bangladesh the per capita income is so low that after meeting the most basic food needs, people have very little to spend on commodities and services produced in the nonfarm sector. The rural processing and manufacturing sector (cottage industry) has a special problem. It is argued that this sector serves the extreme poor, who for obvious economic reasons look for inexpensive products even if they are of low quality. As income increases, people tend to reject some products of cottage industries (often called dying industries) in favor of the better-quality output of formal industries located in urban areas. Thus it is foreseeable that with the expansion of credit facilities the market will be saturated with nonfarm goods and services, leading to a downward pressure on prices and profitability, which might limit expansion of these industries.

In the specific context of the Grameen Bank, it can be argued that the members have not yet faced this problem because the bank is still operating within a small area. The services of the bank have been extended to only about 6 percent of the villages in the country, so members do not have to depend on the local market. If it is saturated they can count on the wider national market by selling products in other areas that are not yet served by the bank. With nationwide expansion of the Grameen Bank, the competition among nonfarm activities would increase and borrowers would have to count more and more on their local markets.

The above proposition, however, takes a static view of the problem. First, agricultural growth and increases in farm productivity may expand the market for nonfarm goods and services more than proportionately through linkage effects. For Bangladesh, a number of recent studies show very high expenditure elasticity of demand for nonfarm goods and services and the majority of rural industry products.[79] Second, the Grameen Bank target group is about half the total population of the country. As their income increases, they could expand the market by demanding each other's products and services.

This appendix analyzes the expenditure pattern of borrower households and compares it with that of nonparticipants in order to clarify the above issue. It cannot be claimed that the information used for this analysis is accurate. The information on expenditures for basic food items was collected for the week preceding the 1985 field surveys, and the figures have been multiplied by 52 to get expenditures for the year. Thus the information would suffer from seasonal variations in expenditures. The information on expenditures for nonfood items like clothing, housing, medical expenses, and personal household effects was collected for fiscal year 1984/85 through a one-time survey and so may contain errors on account of memory recall. The expenditure pattern has been studied by estimating an Engel function of the following type on the cross-section data:

$$E_i = \alpha_i + \beta_i E + \gamma_i E \cdot \log E + \mu_i F + \lambda_i E \cdot F, \qquad (1)$$

where E is the per capita expenditure of

---

[79] S. R. Osmani and N. C. Deb, "Demand for Products of Rural Industries," in *Bangladesh: Selected Issues in Employment and Development*, ed. R. Islam and M. Muqtada (New Delhi: International Labour Organisation, Asian Employment Program, 1986), pp. 151-167; and Hossain, "Agricultural Growth Linkages." pp. 1-30.

Table 49—Expenditure pattern for all sample households, 1984/85

Commodity Group	Average Budget Share	Marginal Budget Share	Expenditure Elasticity of Demand
	(percent)	(percent)	
Food	78.9	69.6	0.88
Cereals	51.3	36.1	0.70
Noncereal crops	9.5	11.5	1.21
Livestock and fisheries	9.6	11.1	1.15
Processed food	8.5	10.9	1.28
Manufactures	13.2	13.6	1.03
Cottage industry	7.7	8.5	1.10
Other industry	5.5	5.1	0.93
Services	8.0	16.8	2.10
Housing	4.0	10.8	2.68
Education	1.1	2.6	2.35
Health	2.1	3.1	1.48
Transport	0.8	0.5	0.56

Source: Estimated by fitting an Engel function on household data for 279 randomly selected households from five project villages and two control villages.

the household, E_i is the amount of expenditure on the ith commodity, and F is the number of persons in the household. This is a nonlinear function that allows for variation in the marginal budget share for the ith commodity, MBS_i, at different levels of income, which can be derived as follows:

$$MBS_i = \beta_i + \gamma_i(1 + \log E) + \lambda_i F. \qquad (2)$$

To avoid the problem of heteroscedasticity, that the variability in E_i increases with the explanatory variable E, the function has been fitted in the following expenditure share form, which is obtained from (1):

$$S_i = \beta_i + \alpha_i/E + \gamma_i \log E + \mu_i \cdot F/E + \lambda_i F, \qquad (3)$$

where $S_i = E_i/E$ is the share of the commodity in total expenditures.

The marginal budget shares and the expenditure elasticity of demand obtained from the estimated functions for all rural households are shown in Table 49. The results from separate estimates of the functions for different participant and nonparticipant groups are given in Table 50.

Cereal and noncereal crops are produced on farms that do not benefit from Grameen Bank loans. The average share of these commodities in the total household budget is nearly three-fifths, but as income increases, the budget share of these commodities (particularly of cereals) declines sharply. About 48 percent of the additional income is spent on these commodities and 52 percent on various nonfarm goods and services. The crops are produced mostly by the Grameen Bank nontarget group. They spent only 37 percent of their additional income on crop sector output and 63 percent on nonfarm goods and services. This shows that as agricultural income increases, the market for nonfarm goods and services expands more than proportionately. The commodities whose markets expand more than proportionately with the increase in farm household income are various rural services, cottage industry products, and processed agricultural goods.

The target-group nonparticipant households (those who own less than 0.5 acre of land but have not yet joined the bank) are the poorest among the three sample groups in Table 50. They spent 57 percent of their additional income on crop sector output and 43 percent on nonfarm goods and services. The corresponding estimates for Grameen Bank participants are 46 and 54 percent, respectively. Compared to nonparticipants the bank members spent proportionately

Table 50—Marginal budget shares and expenditure elasticity of demand for different groups of sample households, 1984/85

	Marginal Share of Budget			Expenditure Elasticity of Demand		
	Target Group			Target Group		
Commodity Group	Participant (N = 69)	Nonparticipant (N = 131)	Nontarget Group (N = 79)	Participant	Nonparticipant	Nontarget Group
	(percent)	(percent)	(percent)			
Food	67.1	80.4	59.4	0.86	0.99	0.79
Cereals	36.2	44.6	25.5	0.69	0.83	0.56
Noncereal crops	9.9	12.5	11.4	1.11	1.34	0.90
Livestock and fisheries	10.4	10.5	12.2	1.15	1.15	1.14
Processed food	10.6	12.8	10.3	1.33	1.46	1.22
(Purchased)	(25.7)	(45.1)	(34.1)	(0.89)	(1.40)	(1.17)
Manufactures	14.9	10.8	13.7	1.10	0.86	1.00
Cottage industry	9.4	6.7	9.2	1.27	0.95	1.10
Other industry	5.5	4.1	4.5	0.90	0.74	0.84
Services	18.0	8.8	26.9	2.20	1.47	2.41
Housing	12.8	4.5	17.1	2.53	1.80	3.05
Education	2.1	2.3	3.6	2.56	3.30	1.84
Health	2.0	2.1	5.2	1.19	1.10	1.90
Transport	1.2	. . .	1.0	1.80	. . .	1.20
Total	100.0[a]	100.0[a]	100.0	1.00	1.00	1.00

Source: Estimated by fitting an Engel function on household data.
Note: N is the size of the sample.
[a] Parts do not add to total because of rounding.

more on housing and cottage industry products. For members the expenditure elasticity of demand is more than one for livestock and fisheries, processed agricultural products, and cottage industry products. Thus, with increases in income, the members themselves expand the market for goods and services financed by Grameen Bank loans.

It is noted that rural processing and manufacturing output has higher expenditure elasticity than have urban industrial products, and their share of the marginal budget is also higher. Further analysis at the disaggregate commodity level (not reported) shows that this is mainly due to very strong demand for wooden furniture and fixtures (carpentry), cane and bamboo products, and mats. For handloom products, the expenditure elasticity is found to be close to unity, while the output of potters and blacksmiths (household utensils) has very low expenditure elasticity.

BIBLIOGRAPHY

Adams, Dale W, and Graham, Douglas H. "A Critique of Traditional Agricultural Credit Projects and Policies." *Journal of Development Economics* 8 (June 1981): 347-366.

Adams, Dale W, and Vogel, Robert C. "Rural Financial Markets in Low-Income Countries: Recent Controversies and Lessons." *World Development* 14 (April 1986): 477-487.

Ahmad, Z. U. "Transaction Cost in Rural Financial Markets in Bangladesh: A Case Study of Rural Credit Markets." Ph.D. dissertation, University of Virginia, 1982 (mimeographed).

Ahmed, Momtaz U. "Financing Rural Industries in Bangladesh." *The Bangladesh Development Studies* 12 (March-June 1984): 59-79.

Ahmed, Raisuddin, and Hossain, Mahabub. "Infrastructure and Development of a Rural Economy." International Food Policy Research Institute, Washington, D.C., 1987 (mimeographed).

Alam, M. F. "Cost of Credit from Institutional Sources in Bangladesh." *The Bangladesh Journal of Agricultural Economics* 4 (December 1981): 51-61.

Antholt, Charles H., and Wennergren, E. B. "Agricultural Credit Reform in Bangladesh: Lessons Learned from a Pilot Project." *The Bangladesh Journal of Agricultural Economics* 8 (June 1985): 35-44.

Asaduzzaman, M., and Hossain, M. *Some Aspects of Agricultural Credit in Two Irrigated Areas in Bangladesh.* Research Report New Series 18. Dhaka: Bangladesh Institute of Development Studies, 1974.

Baker, C. B. "Credit in the Production Organization of the Firm." *The American Journal of Agricultural Economics* 50 (August 1968): 507-520.

______. "Role of Credit in the Economic Development of Small Farm Agriculture." In *Small Farmer Credit: Analytical Papers,* vol. 19, SR 119, pp. 41-70. Washington, D.C.: U.S. Agency for International Development, 1973.

Baker, C. B., and Hopkin, J. A. "Concepts of Finance Capital for a Capital-Using Agriculture." *The American Journal of Agricultural Economics* 51 (December 1969): 1055-1064.

Bangladesh, Bureau of Statistics. *The Bangladesh Census of Agriculture and Livestock: 1983-84,* vol. 1. Dhaka: Government Press, 1986.

______. *Final Report: Labor Force Survey, 1983-84.* Dhaka: Government Press, 1986.

______. *Final Report of Bangladesh Population Census, 1981: Analytical Findings and National Tables.* Dhaka: Government Press, 1984.

______. *Master Survey of Agriculture (Second Round).* Dhaka: Government Press, 1964.

______. *Monthly Economic Situation in Bangladesh.* Dhaka: Government Press, December 1985.

______. *1986 Statistical Yearbook of Bangladesh.* Dhaka: Government Press, 1986.

______. *Report of the Bangladesh Household Expenditure Survey, 1981-82.* Dhaka: Ministry of Planning, 1986.

______. *Statistical Pocket Book of Bangladesh, 1985.* Dhaka: Government Press, 1985.

Bangladesh, Planning Commission. "Intermodal Transport Study: Final Report." Quoted in *The Third Five-Year Plan, 1985-90.* Dhaka: Government Press, 1985.

Bangladesh Institute of Development Studies. *Rural Industries Study Project—Final Report.* Dhaka: BIDS, 1981.

Bangladesh Institute of Development Studies/International Food Policy Research Institute. *Development Impact of the Food for Work Program in Bangladesh.* A report prepared for the World Food Programme. Washington D.C.: BIDS/IFPRI, 1985.

Bangladesh/International Development Association. *Bangladesh Agricultural Credit Review.* Dhaka: Government of Bangladesh/IDA, 1983.

Bardhan, P. K., and Rudra, A. "Interlinkage of Land, Labor and Credit Relations: An Analysis of Village Survey Data in East India." *Economic and Political Weekly* 13 (February 1978): 367-384.

Bashar, M. A.; Elahi, M. Q. I.; and Alam, F. *An Investigation into the Tk 100 Crore Special Agricultural Credit Programme in Some Selected Areas in Mymensingh District.* Research Report 5. Mymensingh: Bureau of Socioeconomic Research and Training, Bangladesh Agricultural University, 1981.

Bhaduri, A. "On the Formation of Usurious Rates of Interest in Backward Agriculture." *Cambridge Journal of Economics* 1 (No. 3, 1977): 341-352.

Bottomley, Anthony. "The Cost of Administering Private Loans in Underdeveloped Rural Areas." *Oxford Economic Papers* 15 (No. 2, 1968): 275-288.

______. "Interest Rate Determination in Underdeveloped Rural Areas." *American Journal of Agricultural Economics* 57 (May 1975): 279-291.

______. "Monopoly Profits as a Determinant of Interest Rates in Underdeveloped Rural Areas." *Oxford Economic Papers* 16 (November 1964): 431-437.

______. "The Premium for Risk as a Determinant of Interest Rates in Underdeveloped Rural Areas." *The Quarterly Journal of Economics* 77 (No. 4, 1963): 637-647.

Braverman, Avishay, and Guasch, J. Luis. "Rural Credit Markets and Institutions in Developing Countries: Lessons of Policy Analysis from Practice and Modern Theory." *World Development* 14 (No. 10/11, 1986): 1253-1267.

Chowdhury, Omar H., and Hossain, Mahabub. "Roads and Development: A Case Study of Return on Investment in Rural Roads in Bangladesh." Dhaka, Bangladesh Unnayan Parishad, 1985 (mimeographed).

David, Cristina C., and Meyer, Richard L. "Measuring the Farm Level Impact of Agricultural Loans." In *Rural Financial Markets in Developing Countries,* pp. 84-95. Edited by J. D. Von Pischke, Dale W Adams, and Gordon Donald. Baltimore and London: Johns Hopkins University Press, 1983.

Fugelsang, Andreas, and Chandler, Dale. *Participation As Process—What We Can Learn from Grameen Bank, Bangladesh.* Oslo: Norwegian Ministry of International Development, 1987.

Ghai, Dharam. *An Evaluation of the Impact of the Grameen Bank Project.* Dhaka: Grameen Bank, 1984.

Ghatak, S. "Rural Interest Rates in the Indian Economy." *Journal of Development Studies* 11 (April 1975): 190-201.

Grameen Bank. "Annual Progress Report: 1986." Grameen Bank, Dhaka, May 1987 (mimeographed).

______. *Annual Report,* various issues. Dhaka: Grameen Bank, various years.

______. *Consolidated Cumulative Statement as of December 31, 1986.* Dhaka: Grameen Bank, 1987.

______. *Consolidated Cumulative Statement as of February 28, 1987.* Dhaka: Grameen Bank, 1987.

Hossain, Mahabub. "Agricultural Growth Linkages—The Bangladesh Case." *The Bangladesh Development Studies* 15 (March 1987): 1-30.

______. *Credit for the Rural Poor: The Grameen Bank in Bangladesh.* Research Monograph 4. Dhaka: Bangladesh Institute of Development Studies, 1984.

______. "Employment and Labour in Bangladesh Rural Industries." *The Bangladesh Development Studies* 12 (March-June 1984): 1-24.

______. "Institutional Credit for Rural Development: An Overview of the Bangladesh Case." *The Bangladesh Journal of Agricultural Economics* 8 (June 1985): 1-16.

______. *Nature and Impact of Modern Rice Technology in Bangladesh.* Research Report 68. Washington, D.C.: International Food Policy Research Institute, forthcoming.

______. "A Note on the Trend of Landlessness in Bangladesh." *The Bangladesh Development Studies* 14 (June 1986): 93-100.

______. "Productivity and Profitability in Bangladesh Rural Industries." *The Bangladesh Development Studies* 12 (March-June 1984): 127-161.

Hossain, Mosharaf; Rashid, A.; and Jahan, S. *Rural Poverty in Bangladesh: A Report to the Like-Minded Group.* Dhaka: Universities Research Center, 1986.

International Fertilizer Development Center. *Agricultural Production, Fertilizer Use and Equity Considerations: Results and Analysis of Farm Survey Data; 1980-82, Bangladesh.* Muscle Shoals, Ala.: IFDC, 1984.

Islam, I., and Khan, H. "Income Inequality, Poverty and Socio-Economic Development in Bangladesh." *The Bangladesh Development Studies* 14 (June 1986): 75-92.

Jones, Steve. "An Evaluation of Rural Development Programs in Bangladesh." *The Journal of Social Studies* (December 1979): 51-92.

Khan, A. R. "Poverty and Inequality in Rural Bangladesh." In *Poverty and Landlessness in Rural Asia,* pp. 137-160. Edited by International Labour Organisation. Geneva: ILO, 1977.

Long, Millard. "Interest Rates and the Structure of Agricultural Credit Markets." *Oxford Economic Papers* 20 (July 1968): 275-288.

______. "Why Peasant Farmers Borrow." *American Journal of Agricultural Economics* 50 (November 1968): 991-1008.

McKinnon, R. I. *Money and Capital in Economic Development.* Washington, D.C.: Brookings Institution, 1973.

Mellor, John W. "Agriculture on the Road to Industrialization." In *Development Strategies Reconsidered,* pp. 67-89. Edited by John P. Lewis and Valeriana Kallab. New Brunswick, N.J.: Transaction Books, 1986.

______. *The New Economics of Growth.* Ithaca, N.Y.: Cornell University Press, 1976.

Mellor, John W., and Lele, Uma. "Growth Linkages of the New Foodgrain Production Technologies." *Indian Journal of Agricultural Economics* 28 (January-March 1973): 35-55.

Meyer, Richard L. "Financing Rural Nonfarm Enterprises in Low-Income Countries." In *Rural Financial Markets in Developing Countries,* pp. 110-116. Edited by J. D. Von Pischke, Dale W Adams, and Gordon Donald. Baltimore and London: Johns Hopkins University Press, 1983.

Muqtada, M. "Determinants and Possibilities of Employment Expansion in the Crop Sector." In *Bangladesh: Selected Issues in Employment and Development,* pp. 61-88. Edited by R. Islam and M. Muqtada. New Delhi: International Labour Organisation, Asian Employment Program, 1986.

______. "Poverty and Inequality: Trends and Causes." In *Bangladesh: Selected Issues in Employment and Development,* pp. 41-60. Edited by R. Islam and M. Muqtada. New Delhi: International Labour Organisation, Asian Employment Program, 1986.

Nesbit, C. "Interest Rates and the Imperfect Competition in the Informal Credit Markets of Rural Chile." *Economic Development and Cultural Change* 16 (No. 1, 1967): 73-90.

______. "The Relationship Between Institutional and Informal Credit Markets in Rural Chile." *Land Economics* 45 (May 1969): 162-173.

Osmani, S. R., and Deb, N. C. "Demand for Products of Rural Industries." In *Bangladesh: Selected Issues in Employment and Development,* pp. 151-167. Edited by R. Islam and M. Muqtada. New Delhi: International Labour Organisation, Asian Employment Program, 1986.

Quasem, M. A., and Hossain, M. "Impact of Agricultural Policies and Programmes on Small Farmers in Bangladesh." Report prepared for the Food and Agriculture Organization of the United Nations, Rome, 1985 (mimeographed).

Rahim, A. M. A. "Agricultural Credit Institutions and Policies in Bangladesh." *The Bangladesh Journal of Agricultural Economics* 8 (June 1985): 17-34.

Rahman, Atiq. "Usury Capital and Credit Relations in Bangladesh Agriculture: Some Implications for Capital Formation and Capitalistic Growth." *The Bangladesh Development Studies* 12 (No. 2, 1979): 1-46.

Rahman, Atiur. *Impact of Grameen Bank Intervention on Rural Power Structure.* Grameen Bank Evaluation Project Working Paper 2. Dhaka: Bangladesh Institute of Development Studies, 1986.

Rahman, Rushidan Islam. *Impact of Grameen Bank on the Situation of Poor Rural Women.* Grameen Bank Evaluation Project Working Paper 1. Dhaka: Bangladesh Institute of Development Studies, 1986.

______. *The Wage Employment Market for Rural Women in Bangladesh.* Research Monograph 6. Dhaka: Bangladesh Institute of Development Studies, 1986.

Siddiqui, Kamal. *An Evaluation of the Grameen Bank Operation.* Dhaka: National Institute of Local Government, 1984.

U.S. Agency for International Development. *Small Farmer Credit: Analytical Papers,* vol. 19. Washington, D.C.: Department of State, 1973.

Von Pischke, J. D., and Adams, Dale W. "Fungibility and the Design and Evaluation of Agricultural Credit Projects." In *Rural Financial Markets in Developing Countries,* pp. 74-83. Edited by J. D. Von Pischke, Dale W Adams, and Gordon Donald. Baltimore and London: Johns Hopkins University Press, 1983.

Von Pischke, J. D.; Adams, Dale W; and Donald, Gordon, eds. *Rural Financial Markets in Developing Countries.* Baltimore and London: Johns Hopkins University Press, 1983.

Wharton, C. "Marketing, Merchandising and Moneylending: A Note on Middlemen Monopsony in Malaya." *Malayan Economic Review* 7 (October 1962): 24-44.

Yunus, Muhammad. "Experiences in Organising Grass Root Initiatives and Mobilising People's Participation: The Case of Grameen Bank Project in Bangladesh." Paper presented at the 25th World Conference of the Society for International Development, Baltimore, Md., 1982. Grameen Bank, Dhaka, 1982 (mimeographed).

______. *The First Decade of Grameen Bank,* 1976-86 (in Bengali). Dhaka: Grameen Bank, 1987.

______. "The Grameen Bank, As I See It." International Labour Organisation, Geneva, 1986 (mimeographed).

______. *Grameen Bank Project in Bangladesh: A Poverty Focussed Rural Development Program.* Dhaka: Grameen Bank, 1982.

RECENT IFPRI RESEARCH REPORTS (continued)

46 *THE EFFECTS ON INCOME DISTRIBUTION AND NUTRITION OF ALTERNATIVE RICE PRICE POLICIES IN THAILAND,* November 1984, by Prasarn Trairatvorakul

45 *THE EFFECTS OF THE EGYPTIAN FOOD RATION AND SUBSIDY SYSTEM ON INCOME DISTRIBUTION AND CONSUMPTION,* July 1984, by Harold Alderman and Joachim von Braun

44 *CONSTRAINTS ON KENYA'S FOOD AND BEVERAGE EXPORTS,* April 1984, by Michael Schluter

43 *CLOSING THE CEREALS GAP WITH TRADE AND FOOD AID,* January 1984, by Barbara Huddleston

42 *THE EFFECTS OF FOOD PRICE AND SUBSIDY POLICIES ON EGYPTIAN AGRICULTURE,* November 1983, by Joachim von Braun and Hartwig de Haen

41 *RURAL GROWTH LINKAGES: HOUSEHOLD EXPENDITURE PATTERNS IN MALAYSIA AND NIGERIA,* September 1983, by Peter B. R. Hazell and Ailsa Röell

40 *FOOD SUBSIDIES IN EGYPT: THEIR IMPACT ON FOREIGN EXCHANGE AND TRADE,* August 1983, by Grant M. Scobie

39 *THE WORLD RICE MARKET: STRUCTURE, CONDUCT, AND PERFORMANCE,* June 1983, by Ammar Siamwalla and Stephen Haykin

38 *POLICY MODELING OF A DUAL GRAIN MARKET: THE CASE OF WHEAT IN INDIA,* May 1983, by Raj Krishna and Ajay Chhibber

37 *SERVICE PROVISION AND RURAL DEVELOPMENT IN INDIA: A STUDY OF MIRYALGUDA TALUKA,* February 1983, by Sudhir Wanmali

36 *AGRICULTURE AND ECONOMIC GROWTH IN AN OPEN ECONOMY: THE CASE OF ARGENTINA,* December 1982, by Domingo Cavallo and Yair Mundlak

35 *POLICY OPTIONS FOR THE GRAIN ECONOMY OF THE EUROPEAN COMMUNITY: IMPLICATIONS FOR DEVELOPING COUNTRIES,* November 1982, by Ulrich Koester

34 *EGYPT'S FOOD SUBSIDY AND RATIONING SYSTEM: A DESCRIPTION,* October 1982, by Harold Alderman, Joachim von Braun, and Sakr Ahmed Sakr

33 *AGRICULTURAL GROWTH AND INDUSTRIAL PERFORMANCE IN INDIA,* October 1982, by C. Rangarajan

32 *FOOD CONSUMPTION PARAMETERS FOR BRAZIL AND THEIR APPLICATION TO FOOD POLICY,* September 1982, by Cheryl Williamson Gray

31 *SUSTAINING RAPID GROWTH IN INDIA'S FERTILIZER CONSUMPTION: A PERSPECTIVE BASED ON COMPOSITION OF USE,* August 1982, by Gunvant M. Desai

30 *INSTABILITY IN INDIAN FOODGRAIN PRODUCTION,* May 1982, by Peter B. R. Hazell

29 *GOVERNMENT POLICY AND FOOD IMPORTS: THE CASE OF WHEAT IN EGYPT,* December 1981, by Grant M. Scobie

28 *GROWTH AND EQUITY: POLICIES AND IMPLEMENTATION IN INDIAN AGRICULTURE,* November 1981, by J. S. Sarma

27 *AGRICULTURAL PRICE POLICIES UNDER COMPLEX SOCIOECONOMIC AND NATURAL CONSTRAINTS: THE CASE OF BANGLADESH,* October 1981, by Raisuddin Ahmed

Mahabub Hossain is a senior research economist at the Bangladesh Institute of Development Studies. He was a visiting research fellow at IFPRI from 1985 to 1987.

RECENT IFPRI RESEARCH REPORTS

64 *COOPERATIVE DAIRY DEVELOPMENT IN KARNATAKA, INDIA: AN ASSESSMENT*, December 1987, by Harold Alderman

63 *INCOME AND NUTRITIONAL EFFECTS OF THE COMMERCIALIZATION OF AGRICULTURE IN SOUTHWESTERN KENYA*, November 1987, by Eileen T. Kennedy and Bruce Cogill

62 *AGRICULTURAL RESEARCH IN NEPAL: RESOURCE ALLOCATION, STRUCTURE, AND INCENTIVES*, September 1987, by Ram P. Yadav

61 *THE PILOT FOOD PRICE SUBSIDY SCHEME IN THE PHILIPPINES: ITS IMPACT ON INCOME, FOOD CONSUMPTION, AND NUTRITIONAL STATUS*, August 1987, by Marito Garcia and Per Pinstrup-Andersen

60 *POPULATION POLICY AND INDIVIDUAL CHOICE: A THEORETICAL INVESTIGATION*, June 1987, by Marc Nerlove, Assaf Razin, and Efraim Sadka

59 *PRODUCTION INCENTIVES IN PHILIPPINE AGRICULTURE: EFFECTS OF TRADE AND EXCHANGE RATE POLICIES*, May 1987, by Romeo M. Bautista

58 *THE FOOD STAMP SCHEME IN SRI LANKA: COSTS, BENEFITS, AND OPTIONS FOR MODIFICATION*, March 1987, by Neville Edirisinghe

57 *CEREAL FEED USE IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 2000*, December 1986, by J. S. Sarma

56 *THE EFFECTS OF TRADE AND EXCHANGE RATE POLICIES ON AGRICULTURE IN ZAIRE*, November 1986, by Tshikala B. Tshibaka

55 *THE EFFECTS OF TRADE AND EXCHANGE RATE POLICIES ON AGRICULTURE IN NIGERIA*, October 1986, by T. Ademola Oyejide

54 *WEATHER AND GRAIN YIELDS IN THE SOVIET UNION*, September 1986, by Padma Desai

53 *REGIONAL COOPERATION TO IMPROVE FOOD SECURITY IN SOUTHERN AND EASTERN AFRICAN COUNTRIES*, July 1986, by Ulrich Koester

52 *FOOD IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 2000*, June 1986, by Leonardo A. Paulino

51 *DETERMINANTS OF AGRICULTURAL POLICIES IN THE UNITED STATES AND THE EUROPEAN COMMUNITY*, November 1985, by Michel Petit

50 *GOVERNMENT EXPENDITURES ON AGRICULTURE AND AGRICULTURAL GROWTH IN LATIN AMERICA*, October 1985, by Victor J. Elias

49 *LIVESTOCK PRODUCTS IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 1990 AND 2000*, April 1985, by J. S. Sarma and Patrick Yeung

48 *RURAL HOUSEHOLD USE OF SERVICES: A STUDY OF MIRYALGUDA TALUKA, INDIA*, March 1985, by Sudhir Wanmali

47 *EVOLVING FOOD GAPS IN THE MIDDLE EAST/NORTH AFRICA: PROSPECTS AND POLICY IMPLICATIONS*, December 1984, by Nabil Khaldi

(continued on inside back cover)

International Food Policy Research Institute
1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 USA

RESEARCH REPORT

66

- R5620 - 1.11F (A) 7/88 -

THE BRAZILIAN WHEAT POLICY: ITS COSTS, BENEFITS, AND EFFECTS ON FOOD CONSUMPTION

Geraldo M. Calegar
G. Edward Schuh

May 1988

INTERNATIONAL
FOOD
POLICY
RESEARCH
INSTITUTE

The **International Food Policy Research Institute** was established in 1975 to identify and analyze alternative national and international strategies and policies for meeting food needs in the world, with particular emphasis on low-income countries and on the poorer groups in those countries. While the research effort is geared to the precise objective of contributing to the reduction of hunger and malnutrition, the factors involved are many and wide-ranging, requiring analysis of underlying processes and extending beyond a narrowly defined food sector. The Institute's research program reflects worldwide interaction with policymakers, administrators, and others concerned with increasing food production and with improving the equity of its distribution. Research results are published and distributed to officials and others concerned with national and international food and agricultural policy.

The Institute receives support as a constituent of the Consultative Group on International Agricultural Research from a number of donors including the United States, the World Bank, Japan, Canada, the United Kingdom, the Netherlands, Australia, the Ford Foundation, Italy, Norway, the Federal Republic of Germany, India, the Philippines, Switzerland, Belgium, and the People's Republic of China. In addition, a number of other governments and institutions contribute funding to special research projects.

Board of Trustees

Dick de Zeeuw
Chairman, Netherlands

Ralph Kirby Davidson
Vice Chairman, U.S.A.

Eliseu Roberto de Andrade Alves
Brazil

Yahia Bakour
Syria

Ivan L. Head
Canada

Dharma Kumar
India

Anne de Lattre
France

James R. McWilliam
Australia

Philip Ndegwa
Kenya

Saburo Okita
Japan

Sukadji Ranuwihardjo
Indonesia

Theodore W. Schultz
U.S.A.

Leopoldo Solís
Mexico

M. Syeduzzaman
Bangladesh

Charles Valy Tuho
Côte d'Ivoire

John W. Mellor, Director
Ex Officio, U.S.A.

THE BRAZILIAN WHEAT POLICY: ITS COSTS, BENEFITS, AND EFFECTS ON FOOD CONSUMPTION

Geraldo M. Calegar
G. Edward Schuh

Research Report 66
International Food Policy Research Institute
May 1988

Copyright 1988 International Food Policy Research Institute.

All rights reserved. Sections of this report may be reproduced without the express permission of but with acknowledgment to the International Food Policy Research Institute.

Library of Congress Cataloging
in Publication Data

Calegar, Geraldo M.
The Brazilian wheat policy.

(Research report ; 66)
Bibliography: p. 61.
1. Wheat trade—Government policy—Brazil.
2. Wheat—Prices—Government policy—Brazil.
I. Schuh, G. Edward (George Edward), 1930-
II. Title. III. Series: Research report (International Food Policy Research Institute) ; 66.

HD9049.W5B79 1988 338.1'8 88-673
ISBN 0-89629-068-9

CONTENTS

Foreword

1. Summary 9

2. Brazilian Wheat Policy 11

3. Analysis of the Aggregate Effects of Wheat Policy on Producers and Consumers 20

4. Distribution of Benefits by Farm Size and Income 32

5. Conclusions 43

Appendix 1: Supplementary Tables 45

Appendix 2: A Simple Model for Analyzing the Effects of Shifting the Subsidy from Wheat to Rice 54

Appendix 3: Alternative Consumption Policies—A Model and Some Results 56

Bibliography 61

TABLES

1. Cultivated area, production, and average yields of wheat, 1962-82 12
2. Estimated real prices at the producer, miller, and border levels for wheat, 1965-82 14
3. Annual per capita consumption of wheat, rice, and beans, 1966-81 16
4. Consumption and imports of wheat grain and selected ratios, 1966-82 17
5. Per capita consumption of wheat by level of expenditure, 1974/75 18
6. Total and per capita consumption of wheat by region, 1972 and 1981 19
7. Retail price of wheat flour relative to prices of rice, beans, cassava flour, and maize flour, 1966-82 19
8. Isolated and combined total monetary effects of the Brazilian wheat policy, 1966-82 27
9. Annual expenditures and budget shares per capita, metropolitan area of Belo Horizonte and rural areas of Minas Gerais and Espírito Santo, 1974/75 35
10. Per capita energy consumption per day, by expenditure group, metropolitan area of Belo Horizonte and rural areas of Minas Gerais and Espírito Santo, 1974/75 36
11. Estimated per capita distribution of yearly costs and benefits of the wheat consumption policy, metropolitan area of Belo Horizonte 37
12. Estimates of direct price elasticities of demand for wheat products and rice, by income group, Juiz de Fora, Minas Gerais, 1973 39
13. Estimated per capita distribution of yearly costs and benefits of the general price subsidy on rice in metropolitan area of Belo Horizonte 39
14. Cumulative share of consumers' expenditure and change in consumers' welfare per expenditure group, Belo Horizonte, 1974 40
15. Estimated daily increase in energy consumption due to a general price consumption subsidy on wheat and rice, Belo Horizonte, 1974 40
16. Current wheat prices, 1965-82 45
17. Total production, seed consumption, consumption by millers, and imports of wheat, 1965-82 46
18. Miscellaneous data for the aggregative analysis of Brazilian wheat policy, 1965-82 46
19. Estimated production and consumption subsidies, evaluated at official and shadow prices of foreign exchange, 1965-82 47
20. Estimated effects of wheat production and consumption policies on quantities produced, consumed, and imported based on the official exchange rate, 1966-82 48

21. Estimated effects of wheat production and consumption policies on quantities produced, consumed, and imported based on the shadow exchange rate, 1966-82 49
22. Estimated effects of the production policy, based on the official exchange rate, 1966-82 50
23. Estimated effects of the production policy, based on the shadow exchange rate, 1966-82 50
24. Estimated effects of the consumption policy, based on the official exchange rate, 1966-82 51
25. Estimated effects of the consumption policy, based on the shadow exchange rate, 1966-82 51
26. Annual per capita expenditures on wheat products and rice, by expenditure group, metropolitan area of Belo Horizonte and rural areas of Minas Gerais and Espírito Santo, 1974/75 52
27. Energy consumption from wheat products and rice per consumer per day, metropolitan area of Belo Horizonte and rural areas of Minas Gerais and Espírito Santo, 1974/75 53
28. Data for derivation of expenditures and changes in consumer welfare curves, Belo Horizonte, 1974/75 53
29. Cost-effectiveness of target-group-oriented programs and a general food price subsidy program with different demand and supply elasticities, as a ratio of the price per unit, 1984 59

ILLUSTRATIONS

1. Multiple price system for wheat 21
2. Behavior of real prices of wheat, 1965-82 24
3. Subsidy levels for wheat, 1965-82 25
4. Production and consumption effects of the wheat subsidy, 1966-82 26
5. Effects of the wheat consumption policy under the official exchange rate, 1966-82 28
6. Effects of the wheat consumption policy under the shadow exchange rate, 1966-82 29
7. Effects of the wheat production policy under the official exchange rate, 1966-82 30
8. Effects of the wheat production policy under the shadow exchange rate, 1966-82 30
9. Hypothetical market for a specific wheat product under two income strata situations and for the aggregated market 33
10. Consumers' welfare distribution 41
11. Retail market for rice in Belo Horizonte 55
12. Hypothetical market for a relevant product for a target group 58

FOREWORD

International Food Policy Research Institute (IFPRI) has a long record of research on various aspects of food subsidies in developing countries, including effects on consumption, production, and foreign trade. In addition to a number of research reports on countries including Brazil, India, Egypt, Bangladesh, Sri Lanka, and the Philippines, a series of working papers on food subsidies is in progress. This extensive body of work examines the social costs and benefits of subsidies from the viewpoint of nutrition, income levels and distribution, and equity between rich and poor and rural and urban, as well as fiscal costs. This large effort has been prompted by the critical importance of food prices to the real incomes of the poor, the large public costs of food subsidy programs, and the potential effects of these policies on food production.

This report on Brazil's wheat subsidies is particularly interesting because the government has intervened extensively in both production and consumption with often conflicting results. In doing so, it has inadvertently created severe strains on the economy that have had far-reaching results. By making available the results of studies such as this, IFPRI provides policymakers with information to choose wisely among the options for increasing agricultural production and feeding the poor, while avoiding the pitfalls that in the long run have high costs not only to efficiency but to equity as well.

John W. Mellor

Washington, D.C.
May 1988

ACKNOWLEDGMENTS

The authors wish to thank Per Pinstrup-Andersen for his support and encouragement throughout the preparation of this report.

Many thanks are also extended to Peter Knight, Mauro Lopes, Inês Lopes, and Roque G. A. Tomasini, who introduced us to the wheat production and consumption issues in Brazil and helped us to gather basic data, without which this study could not have been done.

Helpful comments and suggestions were also provided by Sue Horton, Alberto Valdés, Antônio Salazar P. Brandão, and anonymous referees.

In addition, we also wish to thank the Agricultural Research Center for the Semi-Arid Region of Northeast Brazil, Aldomar Coelho Lima and Antônio Alvino de Souza for their computational assistance, and Ricardo Alves Dantas, who typed the final version.

1

SUMMARY

Large government interventions in Brazil's wheat sector in recent years have raised questions about possible negative effects on resource allocation, expenditure on foreign exchange, and the drain on the public budget. This study is an attempt to identify and measure the main effects of these interventions on welfare, income distribution, and trade.

The two components of Brazilian wheat policy—production and consumption policies—are kept relatively separate. Both components derive from national goals of self-sufficiency in wheat supply, control of inflation, provision of low-cost food for the urban population, and improvement in the distribution of income. To implement its policies, the central government has become the only seller and buyer of both imported and domestically produced wheat. Moreover, the government has maintained rigid control over prices at the producer, wholesale, and retail levels.

This study attempts to estimate the aggregate effects of Brazilian wheat policy on domestic production, consumption, and imports, as well as its subsidy, social, and foreign exchange benefits and costs. It also estimates the effects of the wheat consumption policy on income distribution of a selected area in Brazil, comparing the effects with those of a similar policy for rice.

The basic analytical tools used are standard partial equilibrium and comparative static analyses, whenever necessary making use of the concepts of economic surplus. The first part of the analysis is made at the national level. The effects of production and consumption subsidies on the quantities produced, consumed, and imported, with and without interventions, are estimated, as are the welfare effects for producers, consumers, and for society as a whole during the period 1966-82.

In the second part of the analysis, which is based on disaggregated data, the effects of the consumption policy on the relative and absolute gains for consumers by expenditure group in the metropolitan area of Belo Horizonte and rural areas of the states of Minas Gerais and Espírito Santo are estimated for the year 1974/75.

During the period considered in this study, 1966-82, the Brazilian government made a sustained effort to achieve self-sufficiency in wheat through a production policy that consisted of a guaranteed producer price keyed to the cost of producing wheat. This producer price was generally above border prices evaluated at official exchange rates and below border prices evaluated at the shadow exchange rate. Compared with historical levels, wheat production would have been higher if the free market had prevailed at the shadow exchange rate in 4 years and lower in 13 others. The reason for this disparity is that the cruzeiro (Cr$) was persistently overvalued during this period. Hence, the producer subsidy in most cases only offset the tax resulting from a distorted exchange rate.

The wheat consumption policy, like the production policy, had two main components: an implicit subsidy to consumers resulting from the overvalued currency, and, mainly after 1972, an explicit general price subsidy. Throughout the period, aggregated wheat consumption increased mainly as a consequence of the explicit subsidy, and with the exception of seven years (1966-72), the increase in consumption was greater than the increase in wheat production, when evaluated at the official exchange rate. As a whole, the explicit production subsidy was able to reduce net imports only during the seven years referred to above. The gains in production were small, especially after discounting for the increase in seed demand for the following year in order to increase the area planted.

The wheat production policy for the whole period (1966-82) represented an estimated net subsidy of Cr$11.6 billion (in real 1977 cruzeiros), evaluated at the official exchange rate, and an estimated net tax of Cr$15.3 billion evaluated at the shadow exchange rate. This subsidy was due in part to the rise in the price of wheat in the world market in the mid- and late 1970s, at which time the domestic price set by the government fell short of the border price. In addition, the overvaluation of the cruzeiro represented a tax on producers.

The estimated social costs of the production policy for the whole period were Cr$2.1 billion and Cr$2.9 billion, evaluated at official and shadow exchange rates, respectively (again in real 1977 cruzeiros). The effects on foreign exchange induced by the production policy for the whole period were estimated to be a saving of about Cr$5.0 billion and an expenditure of Cr$16.4 billion. This latter expenditure in foreign exchange was contrary to the stated objective of the explicit production policy. Because of these failures, the wheat policy did not meet its stated objectives satisfactorily.

The total cost of the wheat consumption subsidy for the whole period was about Cr$84 billion at the official rate and Cr$150 billion at the shadow rate. Of this total, estimates show that consumers captured a maximum of 86 percent. However, because of spillover effects (approximately one-third of the total subsidy was captured by those outside of the target group), manipulations by the millers (another one-third) and social costs amounting to about 15 percent of the total cost of the subsidy, only 19 percent of the total subsidy during the period was captured by low-income consumers, the true target group. Thus, the cost-effectiveness of the wheat consumption subsidy is poor. This conclusion is reinforced by the results obtained from alternative consumption policy analysis, in which a general price subsidy for bread was ranked in third place and cost 4.5 to 7.4 times more than a food stamp program.

For foreign exchange expenditure, the wheat consumption subsidy program cost Cr$30 billion at the official exchange rate and Cr$54 billion at the shadow exchange rate. The expenditure was not in accord with one of the objectives of the wheat production policy, that of achieving a saving in foreign exchange. The combined effect of the production and consumption policies is the sum of the individual effects of each policy.

Even though the gains in consumer welfare are slightly biased toward high-expenditure groups, the disaggregative analysis shows that the wheat consumption subsidy contributed to the income redistribution objective by distributing the benefits of the subsidy equitably. When the same subsidy costs for wheat are shifted to rice in a simulated general price subsidy, the distribution of the gains is slightly biased toward the low-expenditure groups. However, two main points should be considered: first, even if a cut in the wheat consumption subsidy (or the simulated rice subsidy) harms the low- and medium-expenditure groups more, the decline in real expenditure is slight (less than 2 percent). Second, the nutritional effect in kilocalories consumed was small—less than 1.5 percent of the total per capita energy intake.

Finally, based on the cases studied in the alternative policy analysis, the wheat consumption subsidy is not an effective policy for redistributing income, nor for dealing with malnutrition problems. The alternative consumption policy analysis shows that if food consumption is to be subsidized, the subsidy should be through a target-oriented program, such as food stamps.

2

BRAZILIAN WHEAT POLICY

Both the production and consumption components of Brazilian wheat policy derive from a number of frequently articulated national goals: self-sufficiency in wheat supply, control of inflation, provision of cheap food for the urban population, and improvement in the distribution of income. To implement its policies, the central government has maintained both a monopolistic and a monopsonistic role in the wheat market, thus making it the only seller and buyer of both imported and domestically produced wheat. Moreover, the government has maintained rigid control over prices at the producer, wholesale, and retail levels.

This study has three main objectives: first, to estimate the total effect of Brazilian wheat policy on the levels of domestic production, consumption, and imports; second, to estimate aggregated subsidy, social, and foreign exchange costs, as well as the social benefits of the policy; and third, to estimate the income distribution effects of the wheat consumption policy for a selected area in Brazil, comparing them with those of a similar policy for rice.

The first part of this chapter deals with production policy, emphasizing the reasons for the chosen policy of self-sufficiency. The second part deals with consumption policy and speculates on the reasons for its particular form. At the end of each part, some questions are raised that should be of interest to policymakers.

Wheat Production Policy

The production side of Brazilian wheat policy has a fairly long history. Wheat was introduced in Brazil in the first quarter of the sixteenth century by the first European settlers. Prior to the mid-1930s, however, there is no indication that the wheat crop ever developed sufficiently to satisfy domestic demand. Because of the absence of a guaranteed market for domestically produced wheat, farmers in the southern states of Brazil (Rio Grande do Sul and Santa Catarina) had little incentive to increase wheat production beyond the amount required to satisfy their own needs. Thus there was little surplus to be marketed. In the mid-1930s the government established a chain of experimental stations to develop production technologies suitable to Brazilian conditions. However, cultivated area and production remained relatively small until 1967 (Table 1), reflecting the high cost of production, poor soils, serious disease problems, difficult climatic conditions, and inadequate scientific and technical support.

Starting in about 1967, cultivated area and production began to increase at a fairly rapid rate, reaching record highs in area in 1979 and in production in 1976 (Table 1). As a whole, however, production has been relatively unstable, primarily because of climatic conditions and diseases, which have made wheat production a somewhat risky activity. Since wheat is an off-season (winter) crop in Brazil, it seldom conflicts with the main in-season (summer) crop, soybeans. The machinery, labor, and some chemical inputs applied to wheat are complementary with soybean production. On the negative side, however, the chronologies of the two crops do not fit perfectly. Soybean production can be reduced about 6 percent, on average, by the delay in planting caused by waiting for the wheat harvest. In the northern part of the states of Paraná, São Paulo, and Mato Grosso, the overlap period is in the fall, when the soybean harvest delays wheat planting.

Because of the risks associated with the production of wheat and the penalty to soybean yields when double-cropped with wheat, there is a large annual variation in

Table 1—Cultivated area, production, and average yields of wheat, 1962-82

Year	Area	Production	Yield
	(hectares)	(metric tons)	(kilograms/ hectare)
1962	258,221	255,404	989
1963	302,122	97,811	324
1964	300,542	213,691	711
1965	354,680	221,576	625
1966	385,028	298,523	775
1967	561,987	364,870	649
1968	845,693	693,598	820
1969	1,299,518	1,146,319	882
1970	1,861,204	1,734,972	932
1971	2,008,215	2,038,632	1,015
1972	2,340,431	693,399	296
1973	1,604,305	1,934,439	1,206
1974	2,212,643	2,848,040	1,287
1975	3,110,830	1,582,587	509
1976	3,520,709	3,037,864	863
1977	3,020,831	2,012,842	666
1978	2,794,365	2,700,707	966
1979	4,104,144	2,881,186	702
1980	3,318,501	2,702,130	814
1981	2,063,747	2,223,632	1,077
1982	2,960,010	1,802,337	609

Sources: Banco do Brasil, "Trigo Nacional," Departamento de Comercialização do Trigo Nacional, Pôrto Alegre, RS, December 1979 (mimeographed); and Banco do Brasil, "Preços de Trigo para os Produtores e Volume de Produção," Departamento de Comercialização do Trigo Nacional, Pôrto Alegre, RS, 1983 (mimeographed).

area planted to wheat as individual farmers adjust their planting to changing conditions. In recent years the area planted in soybeans has increased more rapidly than the area planted in wheat, as some farmers have opted to plant soybeans alone rather than risk a potential failure in the wheat crop. After 1972, the area in soybeans increased faster than that in wheat, and in 1980, 8.6 million hectares were planted to soybeans, whereas only 3.3 million hectares were planted to wheat.

The few alternatives to wheat in the winter season include pasture, oats, flax, and rapeseed. Pasture requires an associated livestock enterprise and is not a viable alternative for all soybean producers. Oats and flax have limited markets. Rapeseed is a new crop being tested at the experimental station level. If viable, it would have a market similar to soybeans with possible application as a substitute for diesel oil.

Guaranteed producer prices have been used to stimulate domestic production of wheat ever since 1938. In recent years the producer price has been set by the National Supply Council (CONAB) and made public by the National Supply Superintendency (SUNAB) through reports of deliberations known as *portarias.* Domestic production is purchased by the Bank of Brazil according to rules designed to avoid frauds, such as those that have occurred in the past. These frauds gave rise to such concepts as "paper wheat" and "wheat nationalization."

Both kinds of fraud had their roots in a dual price system. Because of the production subsidy built into the guaranteed producer price, the price of domestically produced wheat was above the world free market price, while the price of imported wheat was below the free market price because of the implicit consumption subsidy that resulted from a more favorable exchange rate for wheat imports. The "paper wheat" fraud was of two types. The first consisted of an agreement between miller and producer for a pseudo purchase of national wheat, which gave the miller the right to acquire a corresponding quota of the cheaper imported wheat. The second type appeared after Government Decree Number 40,316 of November 8, 1956, which determined that the price of domestically produced wheat consisted of two parts, one paid by the miller at the moment of purchase from the producer, and the other paid by the Bank of Brazil when the producer presented the receipt of sale. With this system it became only a matter of acquiring a receipt of sale for quantities greater than were actually sold, or even nonexistent sales, in order to profit.

The "wheat nationalization" fraud consisted of taking the low-priced wheat imported by the miller through the quota system and following it back to the farmer, from where it returned "nationalized" as being produced domestically at a cost of almost twice that of the imported wheat. Thus, in order to profit through either of these frauds one had only to know how to manipulate the bureaucratic mechanisms.

In order to put an end to these frauds, on November 9, 1962, the government approved a resolution that named the Bank of Brazil as the only direct buyer of domestically produced wheat.[1] As a consequence of the earlier fraud schemes, data on domestic wheat collected prior to 1962, the date of the government resolution, are not considered reliable. Since 1962 these frauds have occurred less frequently.

Self-sufficiency in wheat production has been a policy goal pursued by the government for a long time, primarily through a producer price policy that guarantees prices above world market prices. In addition, however, considerable resources have been provided for the development of marketing facilities. These facilities include cooperatives for supplying inputs, the Bank of Brazil for purchasing the output, and the Brazilian Storage Company (CIBRAZEM) for storing and distributing the production to mills throughout the country.

The main arguments used to justify the goal of self-sufficiency can be grouped in three basic categories—economic, political, and romantic.[2] The economic category includes three arguments. The first, based on foreign exchange considerations, argues that wheat imports consume valuable foreign exchange that should be reserved for importing goods more essential to Brazil's growth.[3] A second argument is that many resources have already been invested in machinery, marketing structures, and other kinds of human and physical capital, and that these investments, as well as the people who depend on them, should not be abandoned because the resources involved are not perfectly mobile. The third argument is that foreign countries, including some of Brazil's major suppliers, subsidize wheat production, and therefore Brazilian producers must be subsidized if they are to compete with foreign exports.

In an attempt to evaluate these arguments, Knight noted that "the main economic argument is that wheat production should not be rapidly reduced, because this policy would involve a waste of resources already committed to wheat or wheat-soybean production, as well as considerable social costs. No valid economic arguments exist, however, for increasing wheat production further until research and extension have drastically altered the efficiency with which resources can be employed in this activity."[4]

Since it is not possible to justify the self-sufficiency policy followed by the government in terms of short-run economic efficiency, one might go further and think in terms of long-run efficiency along the lines of an "infant industry" argument. On these grounds, increasing production over time would be expected either to drive production costs down or give rise to some positive externalities.

Data on the evolution of production costs for wheat over time, however, indicate that they have almost always been equal to the price guaranteed by the government for the respective year.[5] Moreover, with few exceptions, the guaranteed price, calculated at the official exchange rate, from 1967 through 1982 was almost always above world prices. The exceptions were 1973-74 and 1980, when world prices were above domestic producer prices because of a large increase in world wheat prices (Table 2). The infant

---

[1] For details see Ricardo Pereira Soares, *Avaliação Econômica da Política Triticola de 1967 a 1977*, vol. 20. (Brasília: Comissão de Financiamento da Produção, Coleção Análise e Pesquisa, 1980); and Peter Knight, *Brazilian Agricultural Technology and Trade—A Study of Five Commodities* (New York: Praeger, 1971), p. 223.

[2] These arguments were set forth in Knight, *Brazilian Agricultural Technology.*

[3] This has been the basis of much of Brazil's more general import-substituting posture.

[4] Knight, *Brazilian Agricultural Technology.*

[5] Fereração das Cooperativas Brasileiras de Trigo e Soja LTDA, "Custo de Produção: Trigo Revisão Safra, 1983, Soja-Estimativa, 1983-84," Pôrto Allegre, Rio Grande do Sul, 1983; and World Bank, *Brazil: A Review of Agricultural Policies* (Washington, D.C.: World Bank, 1982).

Table 2—Estimated real prices at the producer, miller, and border levels for wheat, 1965-82

Year	Producer Price	Index	Miller Price	Index	Border Price	Index
	(1977 Cr$/ metric ton)	(1965 = 100)	(1977 Cr$/ metric ton)	(1965 = 100)	(1977 Cr$/ metric ton)	(1965 = 100)
1965	3,577	100	2,707	100	3,888	100
1966	3,246	91	2,222	82	3,941	101
1967	3,170	89	2,096	77	3,998	103
1968	3,141	88	2,116	78	3,533	91
1969	3,107	87	2,006	74	3,321	85
1970	2,955	83	2,161	80	2,950	76
1971	2,955	77	2,036	75	2,728	70
1972	2,587	72	1,950	72	2,828	73
1973	2,736	76	1,897	70	4,042	104
1974	3,838	107	1,838	68	5,806	149
1975	3,389	95	1,480	55	4,180	108
1976	3,012	84	1,093	40	3,742	96
1977	3,398	95	1,202	44	2,496	64
1978	3,251	91	1,032	38	2,807	72
1979	2,498	70	732	27	3,103	80
1980	2,424	68	516	19	3,594	92
1981	2,929	82	1,105	41	3,338	86
1982	3,123	87	1,364	50	2,979	77

Source: Calculated by the authors.

Notes: The producer price is the farmgate price adjusted to the mill level. The miller price is the price set by the government, including the consumer subsidy. The border price is the c.i.f. price plus the port-to-mill expenses, using the shadow exchange rate to convert the c.i.f. prices to the domestic currency.

industry argument, therefore, does not appear to be relevant.

To evaluate the foreign exchange savings argument, one can take as a criterion the domestic resource cost of a U.S.$1.00 saving in wheat imports. Previous studies have found that coefficient to be 2.20 for 1967, 2.47 for 1968, 2.00 for 1971, and 1.35 for 1976/77.[6] This means that it cost at least U.S.$1.35 in domestic resources to save U.S.$1.00 in wheat imports, and in some years it cost significantly more.

These data suggest that the production subsidy has not only driven a wedge between domestic and world price, but it may also be worsening the foreign exchange situation. That would be the case if resources were being attracted to the production of wheat at the expense of some other exports that would be socially profitable in terms of generating foreign exchange.

The political arguments favoring domestic wheat production are based on the supposed value of economic autarky. One such argument is that in case of a world war the country might be strongly penalized by its high wheat consumption and the need to depend heavily on imports. A second argument is that countries that supply a large part of these imports might impose economic pressures on Brazil. A third is that there is always the possibility of a large rise in wheat prices in the world market, such as occurred in the mid-1970s, and that paying these prices might create political difficulties at home.

Regarding these political reasons for subsidizing domestic wheat production,

---

[6] Coefficients for 1967 and 1968 are from Knight, *Brazilian Agricultural Technology;* those for 1971 are from José Roberto Mendonça de Barros, "Exportações de Produtos Primários Não Tradicionais," Série IPE Monografias 4, Universidade de São Paulo, 1974, p. 97; and those for 1976/77 are from Pereira Soares, Avaliação Econômica da Política Triticola.

Knight noted that "it should be remembered, however, in weighing these essentially noneconomic arguments, that wheat is not indispensable, and that the production of many low-cost substitutes could be rapidly increased in the event of a future emergency."[7]

The romantic reasons for pursuing the domestic production of wheat are the least important of the three broad sets of arguments set forth above and will not be considered here.[8]

Few studies have attempted to evaluate the real and monetary effects of the wheat production policy over time.[9] But because of current high rates of inflation, the government has recently been forced to cut expenditures in order to balance the budget. As a consequence, questions have been raised about all kinds of subsidies. In the case of wheat subsidies, policymakers would benefit from answers to the following questions: What has been the total treasury cost of the programs? What have been the gains in producers' welfare? What have been the social costs of the subsidies? What have been the savings or losses in foreign exchange? And, what has been the real increase in production due to the subsidies? This study will attempt to provide answers to these questions.

Wheat Consumption Policy

The consumption side of Brazilian wheat policy has a more recent history, even though wheat, in the form of French bread, macaroni, and wheat flour, has been a staple in the consumer's food basket ever since colonial days. Only since 1972, however, when an explicit systematic general consumption subsidy was instituted, has the per capita consumption of wheat shown a clear tendency to increase (Table 3). This subsidy has been a major factor in impeding the attainment of self-sufficiency in wheat production, especially after 1972, because it contributed strongly to keeping the ratio of domestic production to consumption low (Table 4). As a result, imports have supplied an average of approximately 70 percent of domestic consumption in the last 17 years.

Wheat is the major food item imported in Brazil. Both consumption and imports have had a clear tendency to increase over time, with a peak reached for both values in 1980. The value of wheat imports as a share of total value of imports tended downward prior to 1971, but since then it has fluctuated around 3 to 4 percent, in large part because of the consumption subsidy.

According to Luis Eduardo Carvalho, the main reason for providing an explicit consumption subsidy in the period after 1972 was to reduce domestic price inflation, and specifically to escape the effects of the increases in the world price of wheat in the mid-1970s.[10] Concern was also expressed about maintaining the nutritional status of low-income groups. The subsidy was instituted in the expectation that the world price of wheat would soon return to the low levels that prevailed before the increase. But real wheat prices (1967 = 100) did not return to the old levels of U.S.$60-U.S.$70 per metric ton that prevailed in the late 1960s and early 1970s.[11] Instead, the price of wheat rose to U.S.$148 in 1974, went to U.S.$61 in 1977 and to U.S.$71 in 1978, and rose again to U.S.$90 in 1980 and to U.S.$81 in 1981.

The effects of consumption subsidies on inflation are not as straightforward as proponents of such subsidies seem to believe. In a narrow sense, such subsidies can lower

---

[7] Knight, *Brazilian Agricultural Technology.*

[8] Ibid.

[9] See Claudio Roberto Contador, "Trigo Nacional: O Custo Social da Auto-Suficiência," *Estudos Econômicos* 4 (No. 3, 1974): 53-83; Pereira Soares, *Avaliação Econômica da Política Triticola;* and Knight, *Brazilian Agricultural Technology.*

[10] Luis Eduardo Carvalho, "O Caráter Social de Política de Subsídio ao Trigo," *Alimentação e Nutrição* (March 1981): 32-42.

[11] All tons referred to in this report are metric tons.

Table 3—Annual per capita consumption of wheat, rice, and beans, 1966-81

Year	Wheat	Rice	Beans
		(kilograms)	
1966	29.2	43.6	23.4
1967	27.9	45.8	27.2
1968	32.3	45.9	24.6
1969	32.0	41.8	21.7
1970	32.6	47.8	21.5
1971	33.6	42.9	25.7
1972	34.5	48.9	24.9
1973	37.9	43.2	20.2
1974	40.0	40.7	19.4
1975	42.1	42.3	19.4
1976	46.9	52.1	15.0
1977	47.5	48.5	19.4
1978	49.9	40.0	17.4
1979	52.5	45.2	. . .
1980	57.1	47.0	. . .
1981	50.0	50.4	. . .

Sources: Data on wheat consumption are from Brazil, National Supply Superintendency, Departamento do Trigo, "Evolução do Preço do Trigo em Grão para Produtores e Moinhos e Consumo Aparente de Farinha de Trigo," SUNAB, Rio de Janeiro, 1983 (mimeographed); data on population are from Banco Central, *Brasil Programa Econômico: Ajustamento Interno e Externo,* October 1982; and data on rice and beans are from Fundação Instituto Brasileiro de Geografia e Estatística, *Anuário Estatístico do Brasil* (Rio de Janeiro: FIBGE, various years).

the cost of living of particular groups in society. Moreover, wheat products are heavily weighted in the calculation of the general price index. As computed by the Getúlio Vargas Foundation, the General Price Index (IGP-DI) is a weighted average of wholesale prices (0.6), the consumer price index in Rio de Janeiro City (0.3), and the civil construction cost index in Rio de Janeiro (0.1). (The latter was replaced in 1985 by a National Civil Construction Cost Index with the same weight of 0.1.)[12] The wheat and wheat products included in the Wholesale Price Index (IPA-DI) are as follows:

	Weights
Wheat	1.2229
Wheat flour	0.4347
Total	1.6576

Those in the Consumer Price Index in Rio de Janeiro (IPC-RJ) are

	Weights
Wheat flour	0.0756
French bread	3.1819
Subtotal	3.2575
Sandwich loaf	0.2111
Noodles *(massas)*	1.5988
Cakes	0.1571
Cookies	0.3155
Subtotal	2.2825
Total	5.5400

Thus, the total weight for wheat and wheat flour in the IPA-DI corresponds to 0.994690 in the IGP-DI. If the wheat flour and French bread from the IPC-RJ (3.2575 · 0.3 = 0.9773) are added to that, the wheat and wheat products in the IGP-DI will correspond to at least 1.9719 percent of total weight. The other items in the IPC-RJ listed above, including wheat products and others such as maize products, correspond to a weight of 0.684 percent in total IGP-DI. Thus, wheat products correspond to at least 1.9719 percent and, at most, 2.6567 percent of the total weight of the IGP-DI.[13] Hence, on the surface, such subsidies would appear to contribute to reducing measured inflation. However, their government costs contribute to the budget deficit and, consequently, are a general cause of inflation, as has been shown in Egypt[14] and Pakistan.[15]

---

[12] Getúlio Vargas Foundation, "General Price Index."

[13] José L. Carvalho, personal communication, Rio de Janeiro, May 13, 1986.

[14] Grant M. Scobie, *Food Subsidies in Egypt: Their Impact on Foreign Exchange and Trade,* Research Report 40 (Washington, D.C.: International Food Policy Research Institute, 1983).

[15] F. D. McCarthy and Lance Taylor, "Macro Food Policy Planning: A General Equilibrium Model for Pakistan," *Review of Economics and Statistics* 62 (February 1980): 107-121.

Table 4—Consumption and imports of wheat grain and selected ratios, 1966-82

Year	Consumption A	Imports B	Relative Shares		
			(B/A) · 100	(C/A) · 100	(D/E) · 100
	(1,000 metric tons)				
1966	2,448	2,394	98	8	10.5
1967	2,404	2,446	102	10	10.8
1968	2,884	2,621	91	10	7.6
1969	2,908	2,356	81	20	6.6
1970	3,034	1,969	65	32	4.1
1971	3,209	1,711	53	47	3.3
1972	3,378	1,797	53	56	5.1
1973	3,798	2,946	76	12	4.6
1974	4,116	2,399	58	40	3.3
1975	4,437	2,082	47	56	3.9
1976	5,064	3,426	68	25	3.4
1977	5,252	2,608	50	51	2.5
1978	5,656	4,334	77	27	3.8
1979	6,097	3,651	60	38	3.4
1980	6,802	4,755	70	38	3.7
1981	6,098	4,360	72	38	3.2
1982	6,101	4,144	68	30	3.1

Sources: For consumption data: Brazil, National Supply Superintendency, Departamento do Trigo, "Evolução do Preço do Trigo em Grão para Produtores e Moinhos e Consumo Aparente de Farinha de Trigo," SUNAB, Rio de Janeiro, 1983 (mimeographed); for import data, Fundação Instituto Brasileiro de Geografia e Estatística, *Anuário Estatístico do Brasil* (Rio de Janeiro: FIBGE, various years); Banco do Brasil, "Trigo Nacional," Departamento de Comercialização do Trigo Nacional, Pôrto Alegre, RS, 1979; and Fundação Getúlio Vargas, *Conjunctura Econômica*, various issues.

Notes: A = consumption,
B = imports,
C = $(\text{production}_{t-1} - \text{seeds}_t)$,
D = f.o.b. value of wheat imports, and
E = f.o.b. value of all Brazilian imports.

Telma Ferreira e Silva[16] estimated that, as of November 1980, a reduction of the consumption subsidy by 25, 50, and 100 percent would have increased the general price index by 0.57, 1.14, and 2.27 percent, respectively, other things being equal.[17] If one recognizes that during 1980 the inflation rate in Brazil was 110 percent, then it would appear to make little difference, except in a distributional sense, to have an inflation rate 2.27 percent higher by cutting the entire wheat consumption subsidy. Since the effect on the measured rate of inflation of eliminating the subsidy would not be great, and it would have only a one-time effect, then the question remains, "Why doesn't the government eliminate it?" The answer to this question leads to the other major reason for maintaining the consumption subsidy—that the subsidy is supposedly relevant to lowering the price of wheat products to benefit low-income groups who are heavily dependent on those products.

Few studies have been made of this issue.[18] Those that have been made, however, have suggested that the subsidy has benefited medium- and high-income groups more than low-income groups.

---

[16] Telma Ferreira e Silva, "Política Triticola—Efeitos de uma Redução no Subsídio" (M.S. thesis, Universidade Federal de Viçosa, 1981).

[17] Discussion of inflation in Brazil usually focuses on the cost of living *(custo de vida)*.

[18] See Ferreira e Silva, "Política Triticola"; L. E. Carvalho, "Caráter Social de Política de Subsídio ao Trigo"; and Cheryl Williamson Gray, *Food Consumption Parameters for Brazil and Their Application to Food Policy*, Research Report 32 (Washington, D.C.: International Food Policy Research Institute, 1982).

At least two issues of interest arise relevant to the consumption subsidy for wheat. First, this subsidy has in fact benefited mostly medium- and high-income groups in society because those groups (all those above 2X in Table 5) consume more of the three major wheat products than the low-income groups (X-2X in Table 5). Moreover, on a regional basis, the poorer northeast, north, and center-west regions have benefited less from the subsidy than the more developed south and southeast regions (Table 6). This is because the former regions have lower per capita consumption rates than do the latter, even though per capita consumption has increased substantially in the poorer regions since 1972.

Despite the bias of the subsidy in favor of medium- and high-income groups, it is important to note that low-income families spend a larger share of their budget on wheat products (5-6 percent) than do medium- and high-income families (about 1 percent). Thus, in a relative sense a price increase for these products would have a larger relative effect on low-income families, in a situation in which about 72 percent of the economically active population receives only 25 percent of all income.[19]

A second issue is that the consumption subsidy has distorted the relative prices between wheat products and rice, beans, maize flour, and cassava flour, making wheat products relatively cheaper (Table 7) and stimulating their consumption (Table 5). As a consequence of the subsidy, the producers of rice, beans, maize, and cassava, who are usually poor small farmers, have suffered discrimination.

To the authors' knowledge, there have been no previous studies of these two important issues that have attempted to estimate

Table 5—Per capita consumption of wheat by level of expenditure, 1974/75

City	Wheat Product	Average	X	1X − 2X	2X − 4X	4X − 8X	8X − 12X	12X − 20X	20X − 28X	More than 28X
						(grams/person/day)				
Rio de Janeiro	Bread	80	45	67	83	91	91	81	77	73
	Macaroni	19	22	21	19	19	16	12	12	16
	Flour	4	1	2	3	6	7	8	13	10
São Paulo	Bread	73	32	60	74	78	83	81	72	62
	Macaroni	18	13	14	17	19	24	19	19	18
	Flour	6	2	3	4	6	9	13	12	16
Pôrto Alegre	Bread	102	67	90	102	111	104	111	93	101
	Macaroni	15	11	13	16	15	15	10	10	18
	Flour	28	38	35	34	23	18	13	19	13
Distrito Federal	Bread	73	28	52	70	81	87	91	89	84
	Macaroni	13	4	9	13	15	15	15	10	13
	Flour	4	0	1	2	4	6	9	7	13
Belem	Bread	101	69	86	104	121	110	116	109	116
	Macaroni	11	3	7	12	16	16	14	13	16
	Flour	2	0	1	1	3	4	3	6	5

Source: Luis Eduardo Carvalho, "O Caráter Social de Política de Subsídio ao Trigo," *Alimentação e Nutrição* (March 1981): 32-42.

Note: X = a minimum monthly salary per family plus 0.22 of that salary.

---

[19] L. E. Carvalho, "Caráter Social de Política de Subsídio ao Trigo."

Table 6—Total and per capita consumption of wheat by region, 1972 and 1981

Region	Total Consumption		Percent Change	Per Capita Consumption		Percent Change
	1972	1981		1972	1981	
	(metric tons/year)			(kilograms/year)		
Northeast	654,273 (19.0)	1,302,833 (20.7)	99	22.0	37.5	70
Southeast	1,992,703 (57.7)	3,368,399 (53.5)	69	49.4	71.9	46
South	667,594 (19.4)	1,312,557 (20.8)	97	40.0	69.1	73
North	80,727 (2.3)	183,508 (2.9)	127	22.1	30.8	39
Center-West	54,703 (1.6)	132,703 (2.1)	143	10.6	17.6	66
Total	3,450,000 (100.0)	6,300,000 (100.0)	83	35.0	55.3	58

Source: Luis Eduardo Carvalho, "O Caráter Social de Política de Subsídio ao Trigo," *Alimentação e Nutrição* (March 1981): 32-42.

Note: Numbers in parentheses represent the share of the total.

the treasury, social, and foreign exchange costs or the consumer benefits of the consumption subsidy for wheat, or their relative incidence among income groups. Only one study has attempted to evaluate the alternative products to which the wheat subsidy could be changed in order to diminish the spillover effects.[20] That study did not address the issues listed above.

The government has been urged to phase out these subsidies, especially in light of the drain on the budget. However, given economic, social, and political considerations, it has been difficult to do this. In 1980, the government initiated a plan to remove the consumption subsidy gradually, but at the time of this writing it is still high. Moreover, with current high rates of unemployment, and with the economy in disarray, policymakers could benefit from information on both the real and monetary effects of the subsidies, and on possible lower-cost alternatives to wheat consumption subsidy that would help low-income groups.

Table 7—Retail price of wheat flour relative to prices of rice, beans, cassava flour, and maize flour, 1966-82

Year	$\frac{\text{Pwf}}{\text{Pr}}$	$\frac{\text{Pwf}}{\text{Pb}}$	$\frac{\text{Pwf}}{\text{Pcf}}$	$\frac{\text{Pwf}}{\text{Pmf}}$
1966	0.88	0.83	2.00	. . .
1967	0.69	1.20	1.69	1.85
1968	1.00	1.26	1.93	2.20
1969	1.04	0.73	2.06	2.05
1970	1.17	0.85	1.85	1.85
1971	0.99	0.87	1.45	1.83
1972	0.82	0.88	1.35	1.65
1973	0.90	0.42	1.49	1.59
1974	0.73	0.63	1.40	1.42
1975	0.52	0.53	0.94	0.98[a]
1976	0.50	0.20	0.50	0.83[a]
1977	0.60	0.26	0.65	1.06[a]
1978	0.46	0.38	0.75	0.85[a]
1979	0.35	0.22	0.60	0.75[a]
1980	0.28	0.13	0.43	0.62[a]
1981	0.49[a]	0.21[a]	0.53[b]	0.92[a]
1982	0.36[a]	0.36[a]	0.73[a]	1.40[a]

Source: Fundação Instituto Brasileiro de Geografia e Estatística, *Anuário Estatístico do Brasil* (Rio de Janeiro: FIBGE, various years).

Notes: P is price; wf, wheat flour; r, rice; b, beans; cf, cassava flour; and mf, maize flour.

[a] Average for city of São Paulo.

[b] Average for city of Fortaleza.

---

[20] Williamson Gray, *Food Consumption Parameters for Brazil.*

3

ANALYSIS OF THE AGGREGATE EFFECTS OF WHEAT POLICY ON PRODUCERS AND CONSUMERS

This chapter deals with the basic model used to develop the aggregative analysis of the wheat consumption and production policies and the discussions of the main results.

A Model for the Aggregative Analysis

Price policy for the Brazilian wheat sector is implemented by means of a multiple price system. The price for producers is set by the government, generally at levels above world market prices or the price at which wheat can be imported. The difference between these two prices constitutes the producer subsidy.

The consumer price is the price at which the government sells the wheat to millers. This price has, in general, been below the world price. The difference between these prices is the consumption subsidy.

Figure 1 presents this multiple price system graphically. SS, DD, and WW are the domestic supply, domestic demand, and world (export) supply of wheat to Brazil, respectively. The world (export) supply to Brazil is assumed to be perfectly elastic, which means that Brazil is assumed to be a price taker in the world market. This is a plausible assumption because Brazil is a relatively small buyer in the world market, taking an average of only 3.6 percent of total world exports.[21]

Standard partial equilibrium and comparative static analysis, which makes use of the concepts of economic surplus is used as the basic analytical tool in this study. Since the literature on this approach to policy analysis is rather large, the justifications for and limitations of the approach will not be addressed here.[22]

The following measures for evaluating the production policy can be derived from Figure 1:

TCP = treasury cost of the production policy subsidy (area a + b), (1)

CPW = change in producers' welfare (area a), (2)

SCP = social costs in production (area b), (3)

FEP = foreign exchange effect on production (area e + i), and (4)

CQP = change in quantity produced $(Q_p - q_p)$, (5)

where

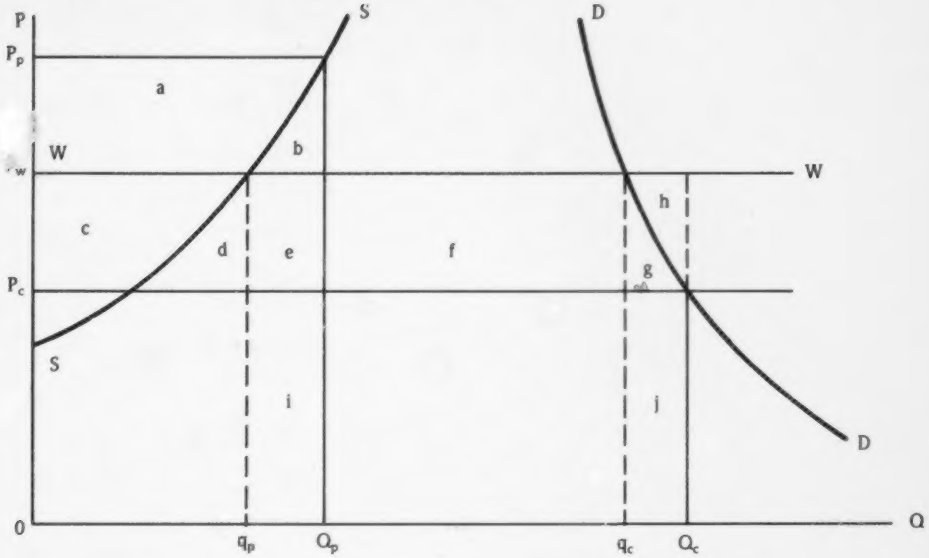
Q_p = quantity produced at the subsidized price, and

---

[21] D. Portela de Lima Fernandes, "Aspectos Econômicos e Estatísticos do Trigo no Brasil," *Informe Agropecuário* 9 (January 1983): 1-8.

[22] Background information can be found in J. M. Curry, J. A. Murphy, and A. Schmitz, "The Concept of Economic Surplus and Its Use in Economic Analysis," *Economic Journal* 81 (December 1971): 741-799; and R. E. Just, D. L. Hueth, and A. Schmitz, *Applied Welfare Economics and Public Policy* (Englewood Cliffs, N.J.: Prentice-Hall, 1982). An application along the lines sought here can be found in Randolph Barker and Yujiro Hayami, "Price Support Versus Input Subsidy for Food Self-Sufficiency in Developing Countries," *American Journal of Agricultural Economics* 63 (February 1981): 8-21.

Figure 1—Multiple price system for wheat



q_p = quantity produced at the world price.

Assuming a constant elasticity supply curve such as $q = aP^{\varepsilon}$, equations (1-5) can be rewritten as

$$TCP = (P_p - P_w)Q_p \, , \quad (6)$$

$$CPW = \int_{P_w}^{P_p} aP^{\varepsilon} dP = [Q_p/(1+\varepsilon)] [P_p - (P_w/P_p)^{\varepsilon} P_w] \, , \quad (7)$$

$$SCP = TCP - CPW \, , \quad (8)$$

$$FEP = P_w Q_p [1 - (P_w/P_p)^{\varepsilon}] \, , \text{ and} \quad (9)$$

$$CQP = Q_p [1 - (P_w/P_p)^{\varepsilon}] \, , \quad (10)$$

where

$P_p = [(P_f + m_a) \cdot 100]/GPI$,

$P_w = [(P_{cif} \cdot ER + m_b) \cdot 100]/GPI$,

and

P_p = producer price adjusted to the wholesale level,

P_f = the farmgate price,

P_w = the border price adjusted to the wholesale level,

P_{cif} = the c.i.f. price,

ER = the equilibrium exchange rate,

GPI = the general price index,

m_a = the farm-to-mill expenses,

m_b = the port-to-mill expenses,

ε = the domestic supply elasticity, and

a = the supply shifter.

To evaluate the consumption policy, one can derive the following measures from Figure 1:

TCC = treasury cost of the consumption policy subsidy [area $(c + d + e + f + g + h)$], (11) CCW = change in consumers' welfare [area $(c + d + e + f + g)$], (12)

SCC = social cost of consumption policy (area h), (13)

FEC = foreign exchange effect on the consumption side [area $(h + g + j)$], (14)

and

CQC = change in quantity consumed $(Q_c - q_c)$, (15)

where

Q_c = quantity consumed at the subsidized price, and

q_c = quantity consumed at the world price.

Assuming a constant elasticity demand curve, such as $q = bp^{-\eta}$, one can rewrite equations (11-15) as

$$\mathrm{TCC} = (P_w - P_c)Q_c, \tag{16}$$

$$\mathrm{CCW} = \int_{P_c}^{P_w} bP^{-\eta}\,dP = [Q_c/(1 - \eta)]\,[(P_c/P_w)^{\eta} P_w - P_c]\,, \tag{17}$$

$$\mathrm{SCC} = \mathrm{TCC} - \mathrm{CCW}, \tag{18}$$

$$\mathrm{FEC} = P_w Q_c[1 - (P_c/P_w)^{\eta}], \text{ and} \tag{19}$$

$$\mathrm{CQC} = Q_c[1 - (P_c/P_w)^{\eta}]\,, \tag{20}$$

where P_c is the consumer price; η, the domestic demand elasticity; and b, the demand shifters.

Finally, the net effects of both the wheat production policy and the wheat consumption policy can be summarized as

$$\mathrm{TTC} = \mathrm{TCP} + \mathrm{TCC}, \tag{21}$$

$$\mathrm{CSW} = \mathrm{CPW} + \mathrm{CCW}, \tag{22}$$

$$\mathrm{TSC} = \mathrm{SCP} + \mathrm{SCC}, \tag{23}$$

$$\mathrm{NEF} = \mathrm{FEP} + \mathrm{FEC}, \text{ and} \tag{24}$$

$$\mathrm{CI}_t = \mathrm{CQC}_t - [\mathrm{CQP}_{t-1} - (\mathrm{SP}_t - \mathrm{SW}_t)],^{23} \tag{25}$$

where

TTC = the total treasury cost,

CSW = the change in social welfare,

TSC = total social cost,

NEF = net effect on foreign exchange,

CI_t = change in imports of wheat in year t,

SP_t = quantity of seeds used in year t at the subsidized producer price,

SW_t = quantity of seeds used in year t if the world price had prevailed, and

CQP_{t-1} = change in quantity produced in year t−1.

The determination of the three main prices to be used in the analysis just described (P_f, P_c, and P_w) involves two main mechanisms: government intervention (P_f and P_c) and free market forces (P_w). In the first semester of each year, before the planting season, the government, through the National Supply Superintendency (SUNAB), makes public the wheat producer price for the year. The political and economic forces involved in the determination of the producer price include the two big cooperatives of wheat and soybean producers in the states of Rio Grande do Sul (FECOTRIGO) and Paraná (OCEPAR), and the government institutions—the Commission for Production Financing (CFP), the Ministry of Agriculture, and the Ministry of Planning—through their bureaucratic and political forces. Basically, these institutions start the bargaining process with estimates of the cost of production for wheat during the year, and from that, they consider other aspects such as self-sufficiency goals.

The determination of miller prices (P_c) during the year is primarily a result of the

---

[23] The expression $[\mathrm{CQP}_{t-1} - (\mathrm{SP}_t - \mathrm{SW}_t)]$ represents the net change in production in year t−1 available for human consumption in year t after adjustment for seeds used in year t.

willingness of the government to have a cheap food policy, for reasons that are not clear, at least on the surface. Some argue that because wheat products are an important component of the consumer price index, then any time the government wants a lower inflation rate for a specific month, it only has to leave the wheat price unaltered. However, this argument should be embraced with caution.

Other than the exchange rate policy followed during the period, there is little government interference in the determination of the import price (P_w); it is determined in the world market. As a rule, the exchange rate policy has been to maintain an overvalued currency in order to subsidize imports, especially capital goods, for the industrialization of the country. This exchange rate policy also works as an implicit import subsidy for wheat, however, thus keeping P_w artificially low domestically.

The nominal rate of protection for producers (NPP) and the nominal rate of protection for consumers (NPC) are used as measures of price distortion that result from government intervention. They are calculated as percentages of the world or border prices, as follows:

$$NPP = [(P_p - P_w)/P_w] \cdot 100, \text{and} \qquad (26)$$

$$NPC = [(P_w - P_c)/P_w] \cdot 100. \qquad (27)$$

The border prices are calculated using the shadow or official exchange rate for each year and "correcting" for 1977 cruzeiros (Cr$) at the wholesale level, taking into account the respective marketing margins. Producer prices are also measured at the wholesale level in 1977 cruzeiros by taking into account the respective marketing margins.

As Bale and Lutz point out, the use of wholesale prices can be justified in a practical sense because wheat grain is transformed into various products between the wholesale and retail levels.[24] As a consequence, a single retail price does not exist for wheat grain.

Given the unavailability of data on stocks, the levels of stocks will be assumed to remain constant and unchanged.

All the data needed for application of the model are reported in Appendix 1, Tables 16 to 18.

Behavior of Real Prices and Estimated Nominal Rates of Protection

Estimates of the real prices of wheat at the producer, miller, and border prices are presented in Table 2. Producer prices are farmgate prices adjusted to the mill level; miller prices are the prices set by the government, and include the consumer subsidy; and border prices are the c.i.f. prices evaluated with the shadow foreign exchange rate (SER) and adjusted to the miller level, exclusive of the consumer subsidy.

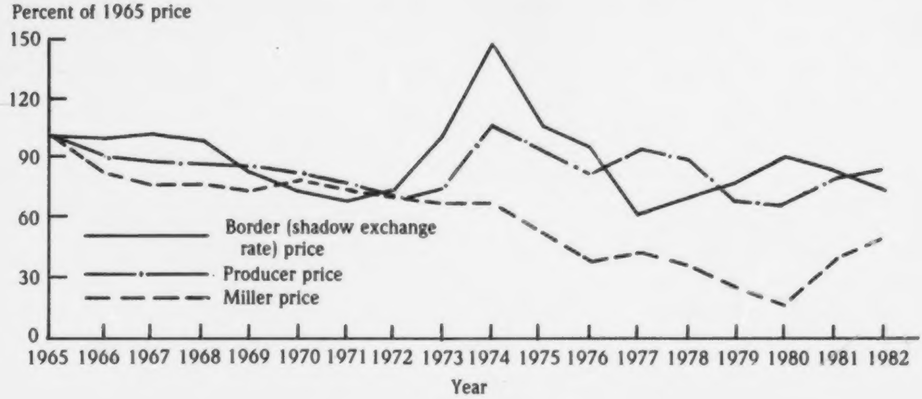
Prices at the miller level declined almost steadily until 1980 (Figure 2), when the lowest price for the period was observed: Cr$516, which was only 19 percent of the highest price of Cr$2,707, in 1965, which was arbitrarily taken as a base of comparison (see Table 2). To understand this trend, it is useful to divide the series into two distinct periods: the first covering the period up to 1972, and the second covering 1973-82. Prior to 1972, the tendency of miller prices to decline in real terms was mainly caused by the downward trend in world prices, represented here by border prices. From 1973 through 1980, the downward trend in miller prices was largely a consequence of the explicit general wheat price consumption subsidy. In 1982, however, a government plan to phase out gradually the wheat consumption subsidy was introduced.

During the same two periods, producer prices experienced rather different trends. From a peak in 1965, the real price at the

---

[24] M. D. Bale and E. Lutz, "Price Distortions in Agriculture and Their Effects: An International Comparison," *American Journal of Agricultural Economics* 63 (February 1981): 8-22.

Figure 2—Behavior of real prices of wheat, 1965-82



producer level declined through 1972 (Figure 2). The observed decline was primarily a result of year-to-year variations in the level of the producer subsidy set by the government. From 1972 through 1982, the pattern of producer prices varied. From 1972 until 1974, they showed a recovery in real terms over 1972. This recovery could be associated with high world prices from 1973 to 1976. The government seems to have followed world prices in setting its guaranteed prices to producers until 1976. From 1976 through 1982, the producer price had a slight tendency to decline. There were two cycles, one beginning in 1976 and the other in 1980.

Finally, border prices tended to decline from 1967 until 1971, following the behavior that had prevailed since the late 1940s.[25] After 1971, border prices experienced a cyclical pattern with two peaks (Figure 2), one in 1974 and another in 1980. Both of these peaks were caused in part by crop failures in the Soviet Union, but also by monetary phenomena in international commodity markets.

The production and consumption subsidies, calculated as a percentage of the border price evaluated at both the official and the shadow exchange rates, are shown in Appendix 1, Table 19 and represented in Figure 3. At the official exchange rate (OER), the production subsidy was positive in 15 years of the period and negative in 3 years. In the years in which the production subsidy was negative, the producers were in fact taxed. This occurred because the border price happened to be far above the guaranteed price set by the government for the domestic producers. The guaranteed price generally has been set at the end of the first semester of each year.

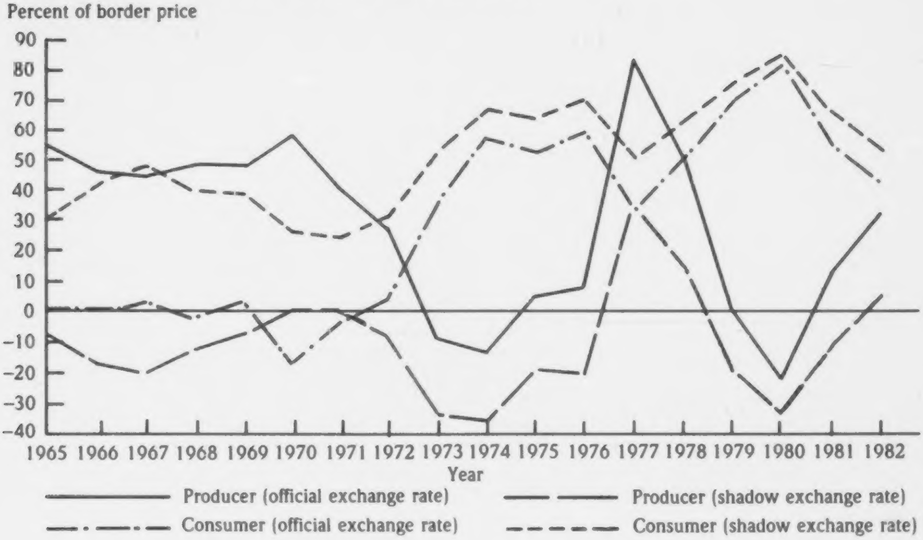
Under the OER, the government pursued a consistent policy of import substitution on the production side until 1982, except for the years 1973, 1974, and 1980, for which the guaranteed producer prices fell short of the border prices.

At least two facts help explain this behavior: first, the instability in the world wheat market, reflected in the rises and declines in border prices after 1972; and, second, the overvaluation of the cruzeiro with respect to the U.S. dollar. As can be seen in Figure 3, when the production subsidy is calculated using the OER, producers were taxed in only three years, 1973, 1974, and 1980, and in two of those years border prices were at their peak. However, when the

---

[25] M. V. Martin and R. F. Brokken, "The Scarcity Syndrome: A Comment," *American Journal of Agricultural Economics* 65 (February 1983): 158-159.

Figure 3—Subsidy levels for wheat, 1965-82



overvaluation of the cruzeiro is taken into account, producers are perceived to receive a lower subsidy. This is because the overvalued currency served as an implicit (export) tax for producers, since it caused domestic prices to be lower than they would have been without the overvaluation.

On the consumption side, the subsidy was mainly an implicit subsidy until 1972, due primarily to the overvaluation of the cruzeiro (Appendix 1, Table 19 and Figure 3). An overvalued currency is an implicit (import) subsidy for consumers because it causes domestic prices to be lower than they would have been without the overvaluation.

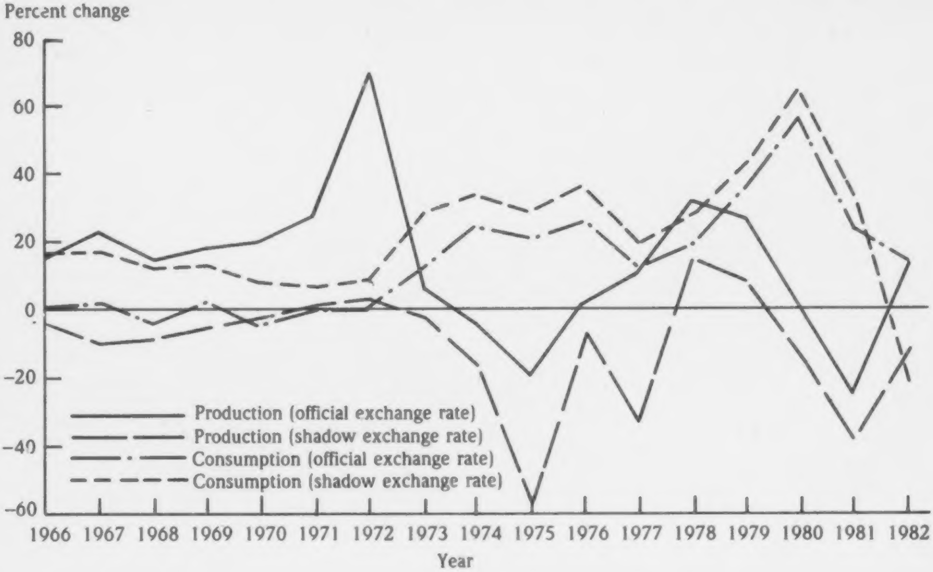
Because of an upturn in the world prices of wheat in 1971 and the end of purchases on concessionary terms from the United States under P.L. 480, the government subsidized wheat consumption explicitly every year from 1972 through 1982. It should be noted that at the OER, it appears that consumers were explicitly taxed during three years of the 1965-71 period. This apparent tax stems from the policy vis-à-vis concessional food purchases, in which wheat was purchased under the concessionary terms of P. L. 480, below world prices and with long-term financing. It was sold in the domestic market at higher prices in order to obtain revenue to finance the wheat subsidy for producers. Of course, this apparent tax disappears when the distortion in the exchange rate is excluded.

Production, Consumption, and Import Effects

Results of the model are presented first under the OER and then under the SER.

Estimates of the effects of the production subsidy or tax on the levels of production under the OER are presented in Appendix 1, Table 20, and represented in Figure 4. As can be seen, the changes in production are positive or negative and vary according to the magnitudes of the producer and border prices and the output level for the respective year. The change in production as a percentage of the level of production that would have resulted if border prices had prevailed was never greater than 31.2 percent, except for the year 1972, when it was 71.1 percent. In three years production was in fact reduced, 1973, 1974, and 1980.

Figure 4—Production and consumption effects of the wheat subsidy, 1966-82



The changes in consumption as a consequence of the consumption subsidy were positive and varied according to the level of consumer and border prices and the consumption level of the respective year. The largest relative change in consumption was in 1980 when the consumption subsidy was at its highest level, 85.6 percent (Table 2, last column) and total consumption was at its highest level, 6.8 million metric tons (Appendix 1, Table 17). In 1980 the total consumption of wheat grain was 56.3 percent higher than it would have been if there had been no consumption subsidy at all (Appendix 1, Table 20, column 7). In evaluating the trade effects of the policies, it is of interest to determine the separate effects of the production policies. These are identified as the change in production and the partial change in import levels shown in Table 20, second and fourth columns, respectively.

The total effect on imports (taking into account both producer and consumer policies) was negative and small during 1966-72, indicating that the wheat production policy had a relatively small effect on self-sufficiency in wheat production. This was so because of the large increase in wheat imports that resulted from the wheat consumption subsidy, especially after 1972.

This is a good example of conflicting policy objectives. On the one hand, the production policy was designed to substitute for wheat imports, while, on the other hand, the consumption policy, although not necessarily designed to stimulate wheat consumption, in fact did so, and this in turn required more imports. Thus, the effect of the wheat production policy, as an import substitution policy, was partially or totally overridden by the consumption policy and the distortion in the exchange rate.

To isolate the effects that overvaluation of the cruzeiro had on the results of Table 20 in Appendix 1, the figures in that table are recalculated using the SER. The results are presented in Appendix 1, Table 21. The production policy has a smaller effect when the distortion in the exchange rate is taken into account. This is because domestic production at world prices would have been larger and the observed production would continue to be the same. On the other hand, the consumption policy has a larger effect on consumption when the distortion in the exchange rate is taken into account. Finally, the total change in imports is larger than when the overvaluation of the currency is not taken into account, mainly as a result of the wheat consumption subsidy. Thus the overvaluation of the cruzeiro works as a deterrent to the import substitution policy.

The effects of production and consumption policies, with and without distortions in the exchange rate, are estimated in Appendix 1, Tables 22-25.

Cost, Benefits, and Exchange Rate Effects

The cost, benefits, and exchange rate effects of the Brazilian wheat policy can be viewed, considering not only the explicit but also the implicit subsidy or tax placed on domestic producers and consumers of wheat products, through the price of wheat set periodically by the government and through the existing exchange rate policy.

A summary of the measurements of the effects for the period of 1966-82 is represented in Table 8. One can see that at the outset, producers and consumers were both explicitly subsidized. However, when the effect of the overvaluation of the currency (the SER)during the period was included, it is clear that producers were taxed and consumers were highly subsidized in a net sense. This was so because an overvalued currency works as an export tax for producers and as an import subsidy for consumers.

The gains in welfare for producers, consumers, and both groups combined ranged from 81-86 percent of the total subsidy value. Under the SER, only producers experienced a loss in welfare. The social cost of the Brazilian wheat policy ranged from 14-19 percent of the total subsidy value, which shows how large the costs of such government interventions can be. The foreign exchange effects of the Brazilian wheat policy were negative in all cases except for the production policy analyzed under the OER.

If it is assumed that one of the major objectives of the wheat production policy is to promote import substitution of wheat, then it can be argued that such a government intervention did not work accordingly in a free market situation. Finally, each dollar of foreign exchange saved or spent due to the wheat production policy has a social cost ranging from 0.17 to 0.43, which means that in order to substitute US$1.00 of wheat imports the government had to spend from US$1.17 to US$1.43 (Table 8

Table 8—Isolated and combined total monetary effects of the Brazilian wheat policy, 1966-82

Exchange Rate	Total Subsidy (Tax) Cost	Change in Welfare as Percent of Total Cost	Social Cost as Percent of Total Cost	Foreign Exchange Effect	Social Cost/ Foreign Exchange
	(U.S. $ million)			(U.S. $ million)	
Production policy					
Shadow	−803.4	−119	19	−865.6	−0.17
Official	820.1	82	18	351.0	0.43
Consumption policy					
Shadow	7,890.2	85	15	−2,847.2	−0.41
Official	5,937.6	86	14	−2,103.0	−0.39
Combined production and consumption policies					
Shadow	7,086.8	81	19	−3,712.8	−0.36
Official	6,757.7	86	14	−1,752.0	−0.54

Source: Calculated by the authors using the total results of Appendix 1, Tables 23-25, and the shadow and official exchange rates for 1977 taken from Appendix 1, Table 18. The minus sign indicates a loss in foreign exchange.

first two lines). (Note that the interpretation of social cost does not depend on whether the sign is negative or positive.) As a whole, each additional US$1.00 of wheat imports had a cost ranging from US$1.36 to US$1.54 (Table 8, fifth and sixth lines of the last column). All these results indicate that the Brazilian wheat policy has been a sizable burden for society as a whole, and in the case of wheat production policy, it cannot be justified as an import substitution policy, because in a free market situation wheat imports tend to increase due to implicit taxation of producers as a result of an overvalued exchange rate.

Figures 5-8 show the behavior of costs, benefits, and foreign exchange effects of both wheat consumption and wheat produc-

Figure 5—Effects of the wheat consumption policy under the official exchange rate, 1966-82

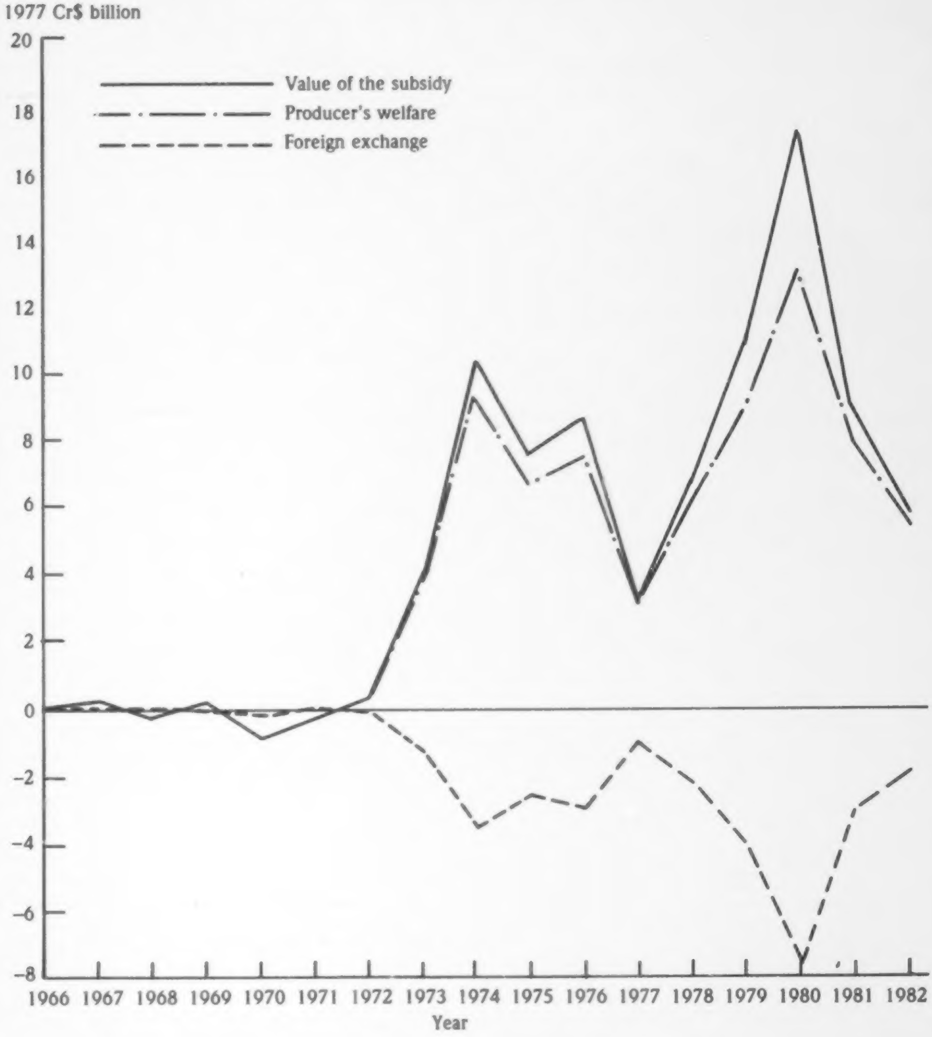


Figure 6—Effects of the wheat consumption policy under the shadow exchange rate, 1966-82

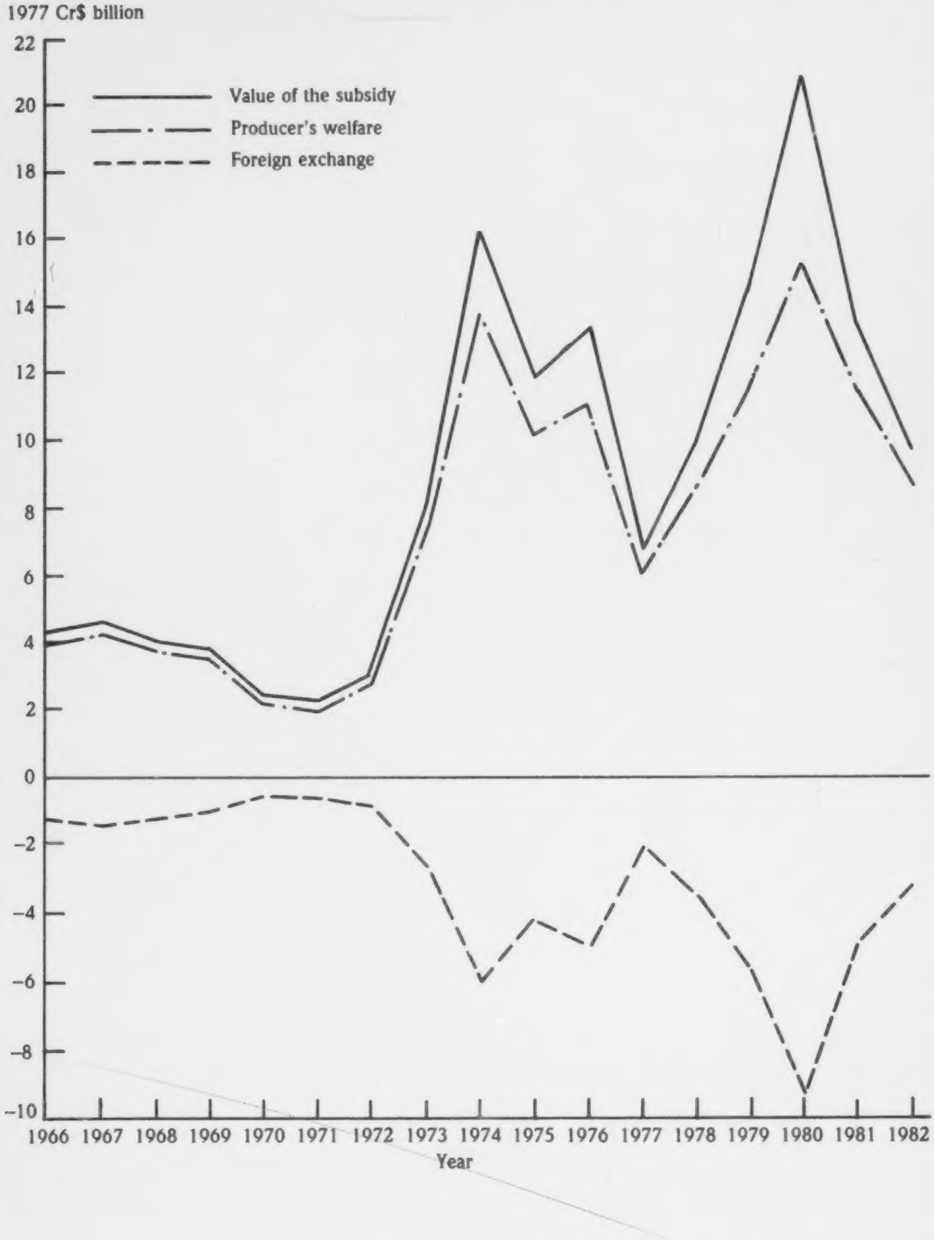


Figure 7—Effects of the wheat production policy under the official exchange rate, 1966-82

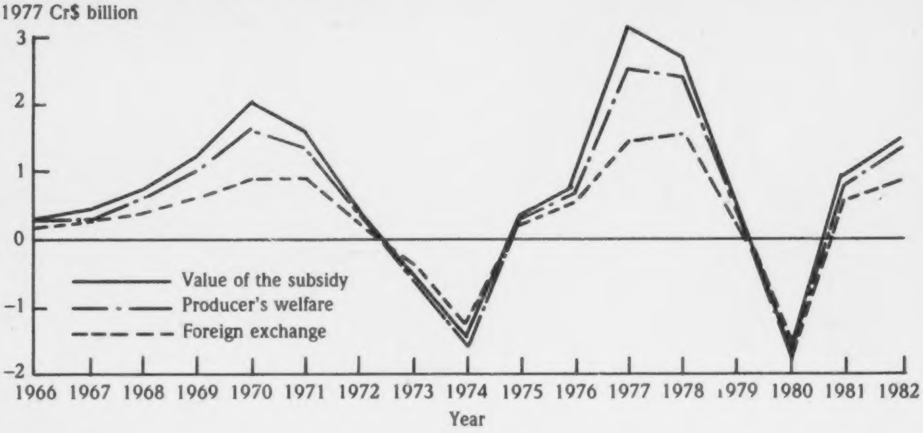
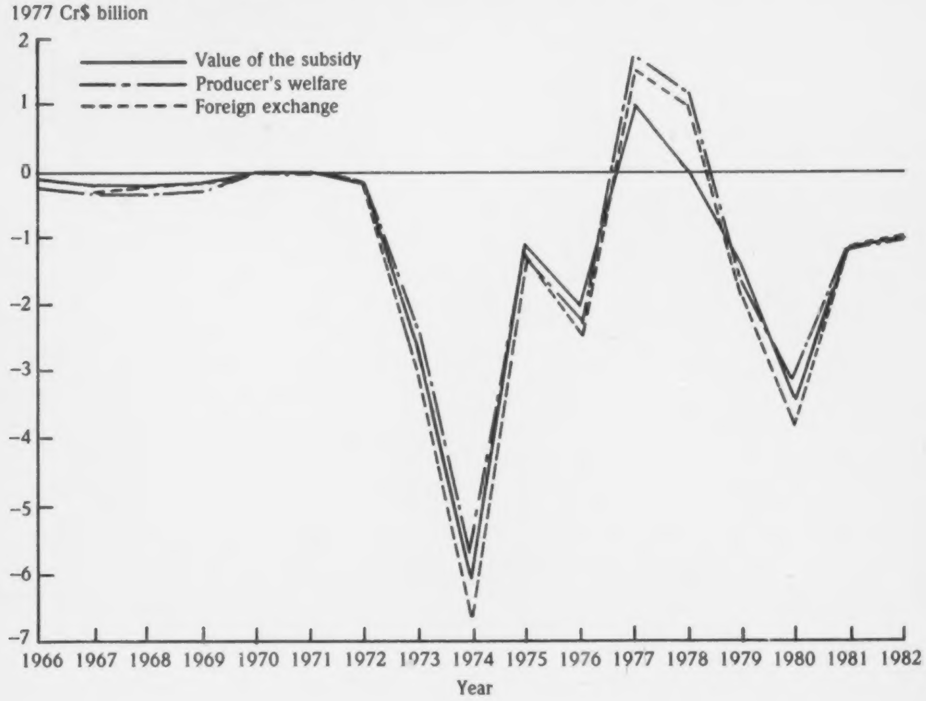


Figure 8—Effects of the wheat production policy under the shadow exchange rate, 1966-82



tion policy for the period 1966-82, under official and shadow exchange rates, respectively. The wheat consumption policy had two distinct subperiods—the first from 1966 to 1972 and the second from 1972 to 1982 (Figures 5 and 6). In the first subperiod, the effects of that policy on the value of the subsidy, producers' welfare, and foreign exchange were small under the OER (Figure 5) and of considerable size under the SER (Figure 6). In the second subperiod, under both OER and SER, the sizes of the policy measures referred to were considerably larger, mainly as a result of the explicit wheat consumption subsidy in effect since 1973. Both the wheat consumption subsidy and the expenditures in foreign exchange reached their maximums in 1980. This is because domestic production was not large enough to meet the domestic demand under the subsidized price.

The wheat production policy had different subperiods of subsidization and taxation of producers during the period of the analysis under both the OER and the SER (see Figures 7 and 8). Under the OER, producers were subsidized until 1972 and again from 1975 to 1979 and from 1981 to 1982. They were taxed during 1973, 1974, and 1980. Under the SER, producers were taxed during most of the period, the exceptions being 1970-71 and 1977-78.

4

DISTRIBUTION OF BENEFITS BY FARM SIZE AND INCOME

Brazilian wheat policy has two basic income distribution effects. The first is at an aggregate level, in which case the issue is the distribution of the implicit and explicit taxes and subsidies between producers and consumers. That issue was considered in the previous section. The second effect is at a disaggregate level, in which case the issue is the distribution of benefits among producers and consumers by size of farm and by level of income.

In this chapter, this second effect is examined. The distributive effects on consumers are emphasized because the consumption policy seems to involve a larger redistribution of income than does the production policy, for two basic reasons. First, total subsidy costs of the wheat consumption policy are larger than those of the production policy, and, second, the whole population of the country consumes wheat products, but, as a rule, wheat is only grown on medium and large farms in the southern part of Brazil. An additional reason for concentrating on the consumption policy is that more consumption data are available for such an analysis, including data on expenditure and consumption of wheat products by expenditure group. Parallel data on the distribution of wheat production by farm size are not available.[26]

A Model for Disaggregative Analysis

The model used to carry out the disaggregative analysis (which applies only to the consumption policy) is similar to that used for the aggregative analysis. The main difference is that the aggregate result here is made up of the sum of the consumers' surplus of all expenditure groups for each wheat product.

The case for one wheat product j and two expenditure strata ($i = 1,2$) is shown in Figure 9. The first two parts of the figure represent alternative expenditure situations and the third part depicts the aggregate market. D_{j1} and D_{j2} represent the respective disaggregate and aggregate demand curves for the particular wheat product, with the aggregate curve of D_j being the horizontal sum of the disaggregate curve of Figure 9. P_0^j and P_1^j, q_0^{ji} and q_1^{ji}, and Q_0^j and Q_1^j are the prices and quantities, with and without price subsidy, respectively, for the wheat product j. Then, using procedures similar to those for the aggregative analysis, policy measures can be derived by using the areas a_i, b_i, c_i, and f_i.

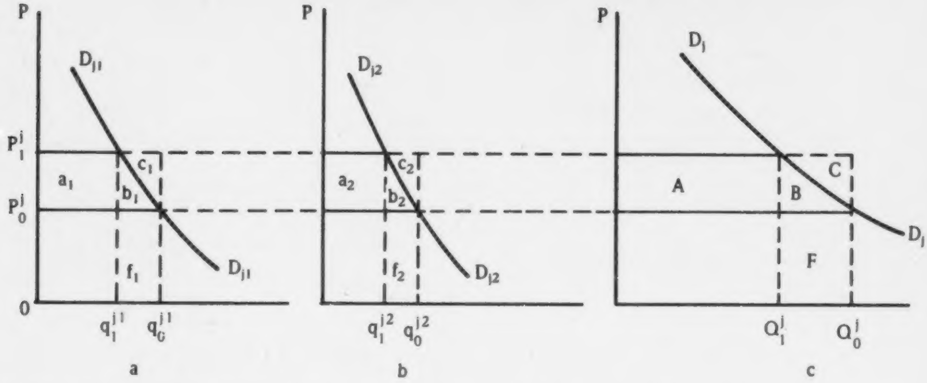
Assuming a constant elasticity demand curve of the form $q_{ji} = a_{ji}\ P - \eta_{ji}$ for each wheat product j and each expenditure stratum i, and generalizing for n expenditure strata and m wheat products, one can derive the following formulas to conduct the disaggregative analysis for a specific year:

$$\begin{aligned} TCC &= \sum_{j=1}^{m} \sum_{i=1}^{n} TCC_{ji} \\ &= \sum_{j=1}^{m} \sum_{i=1}^{n} (P_1^j - P_0^j)\, q_0^{ji}, \qquad (28) \end{aligned}$$

---

[26] In a study of the effect of the distortion in the exchange rate by size of farm for Brazil as a whole, Mauro Lopes found that taxation by overvaluation of the cruzeiro had a regressive effect on income distribution. Large producers can escape the export tax by reorganizing their resources, but this option is not available to the small producers (Mauro R. Lopes, "The Mobilization of Resources from Agriculture: A Policy Analysis of Brazil" [Ph.D. dissertation, Purdue University, 1977]).

Figure 9—Hypothetical market for a specific wheat product under two income strata situations and for the aggregated market



Notes: a and b represent alternative income strata; c represents the aggregated demand.

$$\begin{aligned} CCW &= \sum_{j=1}^{m} \sum_{i=1}^{n} CCW_{ji} \\ &= \sum_{j=1}^{m} \sum_{i=1}^{n} \int_{P_0^j}^{P_1^j} a_{ji} P^{-\eta_{ji}} dp \\ &= \sum_{j=1}^{m} \sum_{i=1}^{n} [q_0^j/(1-\eta_{ji})] \\ &\quad [(P_0^j/P_1^j)^{\eta_{ji}} P_1^j - P_0^j], \end{aligned} \tag{29}$$

$$\begin{aligned} SCC &= TCC - CCW \\ &= \sum_{j=1}^{m} \sum_{i=1}^{n} SCC_{ji}, \text{ and} \end{aligned} \tag{30}$$

$$\begin{aligned} CQC &= \sum_{j=1}^{m} \sum_{i=1}^{n} CQC_{ji} \\ &= \sum_{j=1}^{m} \sum_{i=1}^{n} q^{ji}[1 - (P_0^j/P_1^j)^{\eta_{ji}}], \end{aligned} \tag{31}$$

where

TCC = the total treasury cost on the consumption side for a specific wheat product,

CCW = the change in consumers' welfare,

SCC = the social cost of the subsidy,

CQC = the change in quantity consumed, and

η_{ji} = the constant demand elasticity for wheat product j in each expenditure strata i, where $j = 1,2, \dots m$ $i = 1,2, \dots n$.

P_0^j and P_1^j are the prices of the specific wheat product j with and without the consumption subsidy, respectively, and a_{ji} is the demand shifter for each product j in each expenditure stratum i.

To estimate P_0^j and P_1^j the following formulas can be used:

$$P_0^{wf} = P_{wg} \cdot Q_{wg} + 0_c^{wf}, \tag{32}$$

$$P_1^{wf} = [P_{wg}/(1 - CS_{wg})] Q_{wg} + 0_c^{wf}, \tag{33}$$

$$P_0^j = P_0^{wf} Q_{wf}^j + 0_c^j, \quad \text{and} \tag{34}$$

$$P_1^j = P_1^{wf} Q_{wf}^j + 0_c^j, \tag{35}$$

where

P_k^{wf} = the price of wheat flour with the consumption subsidy, k = 0, and without the consumption subsidy, k = 1;

P_{wg} = the price of wheat grain for the millers;

Q_{wg} = the quantity of wheat grain required to produce 1 kilogram of wheat flour;

0_c^{wf} = other costs involved in the production of wheat flour;

CS_{wg} = the percent value of the average consumption subsidy calculated for a respective year from the aggregative analysis;

P_i^j = the price of wheat product j with the wheat consumption subsidy, k = 0, and without the consumption subsidy, k = 1;

Q_{wf}^j = the quantity of wheat flour required to produce 1 kilogram of the jth wheat product; and

0_c^j = other costs involved in the production of the jth wheat product.

P_0^{wf}, P_{wg}, Q_{wg}, CS_{wg}, P_0^j, and Q_{wf}^j are known from secondary sources; 0_c^{wf} and P_0^{wf} can be calculated from equations (32) and (33); and O_c^j and P_i^j can be determined by substituting them in equations (34) and (35).

After calculating the change in consumers' welfare by expenditure strata, one can go further and derive the respective Lorenz curve for the distribution of the gain in consumers' welfare and compare that distribution with the Lorenz curve resulting from the expenditure distribution of the families in the respective expenditure groups.[27] The relative bias of the wheat consumption subsidy with respect to low- or high-income consumers can then be evaluated.

General Considerations

As a basis for the discussion of the disaggregate effects of the consumption policy on consumers from different expenditure groups, the data set collected by Fundação Instituto Brasileiro de Geografia e Estatística (FIBGE), from now on referred to as the FIBGE survey, and some direct price elasticities estimated by Garcia are examined.[28] Two main considerations are emphasized. The first is the effect of the consumption subsidy on consumers' expenditures on wheat products, and the second is its effect on calorie consumption. In both cases, a specific region of Brazil is considered—Region 4 of the FIBGE survey, which encompasses the states of Minas Gerais and Espírito Santo. Within this region, data on the metropolitan area of Belo Horizonte represent the urban area of Minas Gerais and data on the states of Minas Gerais and Espírito Santo represent the rural area.

For each region of the FIBGE survey total expenditures and consumption of wheat products are almost invariably correlated positively with the total expenditures of the family by expenditure group. This positive correlation indicates that the higher the expenditure group, the greater the absolute benefits captured by the consumers in those groups. The discrepancies in per capita expenditure on wheat products (Table 9), per capita wheat consumption (Table 10), and the estimated per capita wheat consumption subsidy (Table 11) are mainly due to the price differential resulting from differences in composition or quality of the wheat products consumed by each group of consumers in each expenditure group. On the other hand, in the urban area of Belo Horizonte, the budget share of wheat products is inversely correlated with total expenditure by expenditure group. This suggests that, in relative terms, the lower expenditure groups could gain more from the consumption subsidy than the higher expenditure groups.

Thus, for the urban area any decline in the consumption subsidy could lead to a decline in real income because there are few close substitutes for wheat products. An increase in the price of those products means that, on a limited budget, there will

---

[27] For details on the Lorenz curve theory, see Nanak C. Kakwani, *Income Inequality and Poverty—Methods of Estimation and Policy Applications* (New York: Oxford University Press for the World Bank, 1980), p. 377.

[28] Fundação Instituto Brasileiro de Geografia e Estatistica, *Annuário Estatístico do Brasil* (Rio de Janeiro: FIBGE, various years); João Carlos Garcia, "Avaliação dos Impactos do Aumento na Oferta de Alimentos e Renda sobre a Nutrição Humana e suas Implicações para o Estabelecimento de Prioridades de Pesquisas Agrícolas no Brasil" (Ph.D. dissertation, Universidade Federal de Viçosa, 1978).

Table 9—Annual expenditures and budget shares per capita, metropolitan area of Belo Horizonte and rural areas of Minas Gerais and Espírito Santo, 1974/75

Household Expenditure Group	Average Annual Per Capita Expenditure	Wheat Products[a]		Rice		Beans		Cassava Flour		Maize	
		Per Capita Expenditure	Budget Share	Per Capita Expenditure	Budget Share	Per Capita Expenditure	Budget Share	Per Capita Expenditure	Budget Share	Per Capita Expenditure	Budget Share
(Cr $)		(Cr $)	(percent)	(Cr $)	(percent)	(Cr $)	(percent)	(Cr $)	(percent)	(Cr $)	(percent)
Metropolitan area											
Less than 4,500	1,604	56	3.5	70	4.4	44	2.7	15	0.9	13	0.8
4,500–8,999	1,749	57	3.3	105	6.0	51	2.9	13	0.7	14	0.8
9,000–11,299	2,549	86	3.4	154	6.0	60	2.4	19	0.7	14	0.5
11,300–15,799	2,692	87	3.2	144	5.3	53	2.0	9	0.3	12	0.4
15,800–22,599	3,793	111	2.9	164	4.3	63	1.7	15	0.4	12	0.3
22,600–31,599	4,453	122	2.7	143	3.2	54	1.2	10	0.2	10	0.2
31,600–45,199	5,919	143	2.4	132	2.2	50	0.8	9	0.2	10	0.2
45,200–67,799	10,869	182	1.7	154	1.4	60	0.5	12	0.1	9	0.1
More than 67,999	27,494	229	0.8	131	0.5	51	0.2	25	0.1	16	0.1
Mean	6,755	123	1.8	140	2.1	54	0.8	13	0.2	12	0.2
Rural area											
Less than 2,300	530	9	1.6	39	7.3	46	8.6	21	3.9	14	2.6
2,300–3,399	955	19	2.0	77	8.1	70	7.3	28	2.9	39	4.1
3,400–4,499	991	21	2.1	93	9.4	65	6.5	20	2.0	36	3.7
4,500–6,799	1,123	28	2.5	112	10.0	69	6.1	22	2.0	38	3.4
6,800–8,999	1,574	39	2.5	159	10.1	88	5.6	23	1.4	48	3.0
9,000–15,799	1,690	42	2.5	163	9.7	79	4.7	14	0.8	48	2.8
15,800–22,599	2,670	60	2.3	190	7.1	91	3.4	19	0.7	54	2.0
22,600–31,599	3,778	67	1.8	221	5.8	84	2.2	17	0.4	55	0.6
More than 31,599	7,863	104	1.3	265	3.4	98	1.2	20	0.3	43	0.6
Mean	2,268	48	2.1	172	7.6	87	3.9	21	0.9	50	2.2

Source: Fundação Instituto Brasileiro de Geografia e Estatística, *Estudo Nacional da Despesa Familiar: Despesas das Famílias, Dados Preliminares,* 6 vols. (Rio de Janeiro: FIBGE, 1978 and 1979).

[a] Wheat products include wheat bread, macaroni, and wheat flour.

Table 10—Per capita energy consumption per day, by expenditure group, metropolitan area of Belo Horizonte and rural areas of Minas Gerais and Espírito Santo, 1974/75

Household Expenditure Group	Total Kilocalories per Day	Wheat Products[a]		Rice		Beans		Cassava Flour		Maize	
		Kilocalories per Day	Percent of Total	Kilocalories per Day	Percent of Total	Kilocalories per Day	Percent of Total	Kilocalories per Day	Percent of Total	Kilocalories per Day	Percent of Total
(Cr $)											
Metropolitan area											
Less than 4,500	1,457	189	13.0	274	18.8	152	10.4	28	1.9	122	8.4
4,500–8,999	1,824	196	10.7	435	23.8	187	10.3	21	1.2	94	5.2
9,000–11,299	1,852	236	12.7	465	25.0	169	9.1	22	1.2	68	3.7
11,300–15,799	1,903	247	13.0	470	24.7	161	8.5	12	0.6	66	3.5
15,800–22,599	1,933	257	13.3	475	24.6	161	8.3	16	0.8	57	2.9
22,600–31,599	2,027	297	14.7	453	22.3	154	7.6	12	0.6	52	2.6
51,600–45,199	2,138	339	15.9	412	19.3	136	6.4	14	0.7	41	1.9
45,200–67,799	2,170	338	15.6	386	17.8	129	5.9	11	0.5	32	1.5
More than 67,799	2,323	356	15.3	321	13.8	102	4.4	17	0.7	30	1.3
Mean	2,040	289	14.2	423	20.7	146	7.2	15	0.7	52	2.5
Rural area											
Less than 2,300	1,476	33	2.2	186	12.6	297	20.1	245	16.6	150	10.1
2,300–3,399	1,865	57	3.1	272	14.6	296	15.9	213	11.4	250	13.4
3,400–4,499	1,972	75	3.8	337	17.1	284	14.4	179	9.1	291	14.8
4,500–6,799	2,098	88	4.2	410	19.5	311	14.8	176	8.4	270	12.9
6,800–8,999	2,212	104	4.7	465	21.0	301	13.6	149	6.7	271	12.3
9,000–15,799	2,420	123	5.1	551	22.8	302	12.5	117	4.8	294	12.1
15,800–22,599	2,611	161	6.2	557	21.3	321	12.3	134	5.1	232	8.9
22,600–31,599	2,715	169	6.2	660	24.3	286	10.5	111	4.1	234	8.6
More than 31,599	2,784	191	6.9	663	23.8	273	9.8	98	3.5	146	5.2
Mean	2,354	122	5.2	506	21.5	300	12.7	140	5.9	256	10.9

Source: Fundação Instituto Brasileiro de Geografia e Estatística, "Special Runs of ENDEF: Consumption in Calories by Global Income Classes; Annex-A: Number of Days Researched; Annex-B: Average Number of Comensal Days," FIBGE, Rio de Janeiro (mimeographed).

[a] Wheat products include wheat bread, macaroni, and wheat flour.

Table 11—Estimated per capita distribution of yearly costs and benefits of the wheat consumption policy, metropolitan area of Belo Horizonte

Household Expenditure Group	Annual per Capita Expenditure (PCE)	Annual per Capita Subsidy (PCS)	Change in Consumer Welfare (CCW)	Percent of PCS	Social Cost	Percent of PCS	$\frac{CCW}{PCE} \cdot 100$
(1974 Cr $)		(1974 Cr $)			(1974 Cr $)		(percent)
Less than 4,500	1,604	33.8	32.8	97	1.0	3	2.04
4,500–8,999	1,749	33.7	32.0	95	1.7	5	1.83
9,000–11,299	2,549	40.1	38.0	95	2.1	5	1.49
11,300–15,799	2,692	41.2	39.1	95	2.1	5	1.45
15,800–22,599	3,793	42.6	40.7	97	1.9	3	1.07
22,600–31,599	4,453	48.2	46.6	99	1.6	1	1.05
31,600–45,199	5,919	54.1	53.7	99	0.4	1	0.91
45,200–67,799	10,869	53.3	52.8	99	0.5	1	0.49
More than 67,799	27,494	55.4	54.6	99	0.8	1	0.20

Source: Calculated by the authors based on data provided by Fundação Instituto Brasileiro de Geografia e Estatística.
Note: Wheat products include wheat bread, macaroni, and wheat flour used directly by consumers.

be less money to allocate to other products. Moreover, the medium- and low-income groups will lose more, relative to their total expenditures, than the high-income groups.

In the rural areas, both the amount consumed and the expenditures on wheat products increase as the expenditure groups ascend. However, the budget shares present a stable maximum for the middle groups (the same figure applies for more than one stratum), while declining as total expenditure increases. These data support the hypothesis that in rural areas, the consumption subsidy has benefited the higher expenditure groups in absolute terms and the medium expenditure groups in relative terms.

A comparison of energy consumption as a percentage of total kilocalories consumed per day in the metropolitan area with that in the rural areas (Table 10) shows clearly that the wheat consumption policy has discriminated against rural consumers because wheat products play a smaller part in their diets. Moreover, in both rural and urban areas, the higher the expenditure group, the higher the consumption of wheat products in absolute terms.

Taking the observations for the urban and rural areas together, one can conclude that much of the budgetary cost of the wheat consumption subsidy was captured by those who were not targeted—those in the high- and medium-expenditure groups. Thus the cost-effectiveness of this general price subsidy was probably quite low.[29]

For purposes of comparison, data on budget share and calorie consumption for rice, beans, cassava flour, and maize are also included in Tables 9 and 10. In the Belo Horizonte metropolitan area, rice had the largest budget share among the five products. This implies that a general price consumption subsidy on rice (at the same subsidy level as wheat) would do a better job of redistributing income, provided the price elasticities of demand by income groups for both products behaved similarly.

For the metropolitan area, all other products in Tables 9 and 10 are better suited to be target-oriented than wheat products (in terms of a general price subsidy to benefit low-income people). That is, both budget shares and per capita calorie consumption in general tend to decline as expenditure increases. However, the decline is less rapid for wheat products than it is for other products.

---

[29] The cost incurred by the government per unit of change in nutrient consumption by the target group was high, that is, the effectiveness of the money spent in that program was low. Some figures are presented in Appendix 3.

Estimates of the price elasticities of demand for wheat products and for rice are presented in Table 12. The absolute sizes of the elasticities for bread and macaroni tend to increase as income increases and to decline at higher expenditure levels. Atypically, the price elasticity of demand for wheat flour increases continuously in absolute terms as income increases. For rice, the price elasticity declines continuously as family income increases.

Distributional Effects

The effects of the 1974/75 consumption subsidy on the distribution of expenditure of the population of the Belo Horizonte metropolitan area are quantified using the data presented in Appendix 1, Tables 26 and 27, and Table 11, and the formulas developed earlier in this chapter (equations 28-35). These calculations provide a rough idea of the distributional effects of the consumption policy when the distortion in the exchange rate is taken into account (Table 11).

The amount of subsidy per capita estimated by expenditure group increases with the increase in expenditure level because the quantity of wheat products consumed increases as income rises. Consumer welfare as a percentage of the per capita subsidy increases for all groups except the second and the eighth. This is primarily a result of the size and behavior of the different price elasticities of demand for wheat bread, macaroni, and wheat flour (Table 12). The results presented in Table 11 were obtained from the summation of these individual results.[30]

The social cost is greater for the low- and medium-expenditure consumers than for the upper expenditure groups primarily because of the size of the price elasticity of demand.

The last column of Table 11 shows the relative effects of the consumption subsidy on the consumers' real expenditures. The first four expenditure groups have a greater relative gain than the remaining groups. These results suggest that a cut in the consumption subsidy would hurt the low and medium expenditure groups relatively more than the higher ones.

In an attempt to evaluate the effects of transferring the consumption subsidy from wheat to rice, the same policy measures were estimated for rice as for wheat in Table 13, with its value of the subsidy expected to be the same. (For details on the methodology and data set used to derive the results in Table 13, see Appendix 2.) Three main advantages appear to favor a rice subsidy over wheat. First, the change in consumers' welfare is larger for the expenditure groups up to the sixth with the exception of the first (lowest) group. Second, the social costs are low due to the lower price elasticity of demand. And finally, the increase in the real expenditure power, represented by the percentage of increase in expenditure due to the subsidy, is larger for the simulated rice subsidy, which can be seen by comparing the last columns of Tables 11 and 13. All of these results are mainly due to the higher per capita consumption of rice in all expenditure groups, especially the lowest, and to the small and decreasing size of the price elasticities of demand for rice as income increases (see the last column of Table 13).

Table 14, which is derived from Tables 11 and 13, and Appendix 1, Table 28, presents the cumulative distribution of consumers' total expenditures and change in welfare for both wheat and rice. Those cumulative distributions are used for drawing the concentration curves in Figure 10.[31] With the exception of the first two expenditure strata, the distribution of the change in consumers' welfare when the consumption subsidy is on rice is slightly biased toward the two lowest expenditure groups. This is because the cumulative percentage of the change in consumers' welfare for rice is almost always greater than that for wheat, and it is also greater than the cumulative percentage of the population.

Figure 10 shows five basic curves. Curve A is the change in the consumers' welfare

---

[30] The individual results are not presented but can be obtained from the authors.

[31] These curves have interpretations analogous to the Lorenz curve for income distribution.

Table 12—Estimates of direct price elasticities of demand for wheat products and rice, by income group, Juiz de Fora, Minas Gerais, 1973

Household Income Group	Demand Elasticities			
	Wheat Bread	Macaroni	Wheat Flour	Rice
(Cr $)				
Less than 4,591	−0.199	−0.119	−0.284	−0.153
4,591−7,143	−0.427	−0.144	−0.472	−0.150
7,144−10,053	−0.486	−0.127	−0.512	−0.126
10,054−13,158	−0.484	−0.107	−0.528	−0.105
13,159−18,645	−0.407	−0.082	−0.553	−0.078
18,646−32,978	−0.220	−0.058	−0.566	−0.058
32,979−44,991	0.000	−0.041	−0.559	−0.040
44,992−74,876	0.000	−0.028	−0.575	−0.026
74,877−166,835	0.000	−0.014	−0.589	−0.014

Source: João Carlos Garcia, "Avaliação dos Impactos do Aumento na Oferta de Alimentos e Renda sobre a Nutrição Humana e suas Implicações para o Estabelecimento de Prioridades de Pesquisas Agrícolas no Brasil" (Ph.D. dissertation, Universidade Federal de Viçosa, 1978).

distribution when the subsidy is on rice. Curve B is the perfect equality curve. Curve C is the same as curve A, but the subsidy is on wheat. Curve D is the expenditure distribution curve. And finally, curve E is the line of perfect inequality.

Some important deductions can be drawn from Figure 10. First, because curve A is above curve B, except for the first two expenditure groups, the distribution of benefits of a rice consumption subsidy is biased toward low-expenditure people. The reverse is true for curve C. However, since curve C is above curve D, the wheat consumption subsidy—though biased toward high-expenditure groups—has some power to redistribute expenditure and income because it increases the purchasing power.

The main problem with both the subsidies on wheat and rice is their low cost-effectiveness, as the result of a large spillover of benefits to nontargeted groups. This will be shown in Appendix 3.

A final question is, "Which consumption subsidy would be better from a nutritional standpoint?" Both wheat and rice products are rich calorie sources; therefore, the per capita daily gain in calories due to the sub-

Table 13—Estimated per capita distribution of yearly costs and benefits of the general price subsidy on rice in metropolitan area of Belo Horizonte

Household Expenditure Group	Annual per Capita Expenditure (PCE)	Annual per Capita Subsidy (PCS)	Change in Consumer Welfare (CCW)	Social Cost	Percent of PCS	$\frac{CCW}{PCE} \cdot 100$
(1974 Cr$)		(1974 Cr$)		(1974 Cr$)		(percent)
Less than 4,500	1,604	29.5	28.8	0.7	2.3	1.80
4,500−8,999	1,749	47.5	46.3	1.2	2.5	2.65
9,000−11,299	2,549	50.8	49.5	1.3	2.6	1.94
11,300−15,799	2,692	51.4	50.1	1.3	2.5	1.86
15,800−22,599	3,793	51.9	50.6	1.3	2.5	1.33
22,600−31,599	4,453	49.5	48.2	1.3	2.6	1.08
31,600−45,199	5,919	45.0	43.9	1.1	2.4	0.007
45,200−67,799	10,869	42.2	42.1	1.1	2.6	0.004
More than 67,799	27,494	35.1	34.2	0.9	2.6	0.001

Source: Calculated by the authors.

Table 14—Cumulative share of consumers' expenditure and change in consumers' welfare per expenditure group, Belo Horizonte, 1974

Household Expenditure Group	Cumulative Share of Consumer Welfare[a]	Cumulative Share of Total Expenditure[a]	Cumulative Share of CCW with Wheat Subsidy[b]	Cumulative Share of CCW with Rice Subsidy[b]
(Cr $)		(percent)		
Less than 4,500	1.2	0.3	0.9	0.8
4,500–8,999	11.3	2.9	8.3	11.0
9,000–11,299	18.4	5.6	14.4	18.6
11,300–15,799	33.6	11.6	27.9	35.1
15,800–22,599	51.3	21.5	44.3	54.6
22,600–31,599	67.8	32.4	61.8	71.9
31,600–45,199	81.0	43.9	78.0	84.6
45,200–67,799	89.5	57.6	87.0	92.2
More than 67,799	100.0	100.0	100.0	100.0

Source: Calculated by the authors.
Note: CCW is the change in consumer welfare.

[a] Obtained from Columns 3 and 4 of Appendix 1, Table 28.

[b] Obtained from cumulative multiplication of the changes in consumer welfare from Table 11 by the number of consumers in Appendix 1, Table 28.

[c] Obtained from cumulative multiplication of the changes in consumer welfare from Table 13 by the number of consumers in Appendix 1, Table 28.

sidy for each product is evaluated (Table 15). In both cases, the increase in calorie consumption was relatively small—less than 1.5 percent of per capita calorie consumption—because of the relatively low values of the price elasticities of demand for both products. In effect, the subsidies were working more as an income transfer than as an instrument to stimulate food consumption directly.

The spillover effect of these subsidies on either wheat or rice is large because the

Table 15—Estimated daily increase in energy consumption due to a general price consumption subsidy on wheat and rice, Belo Horizonte, 1974

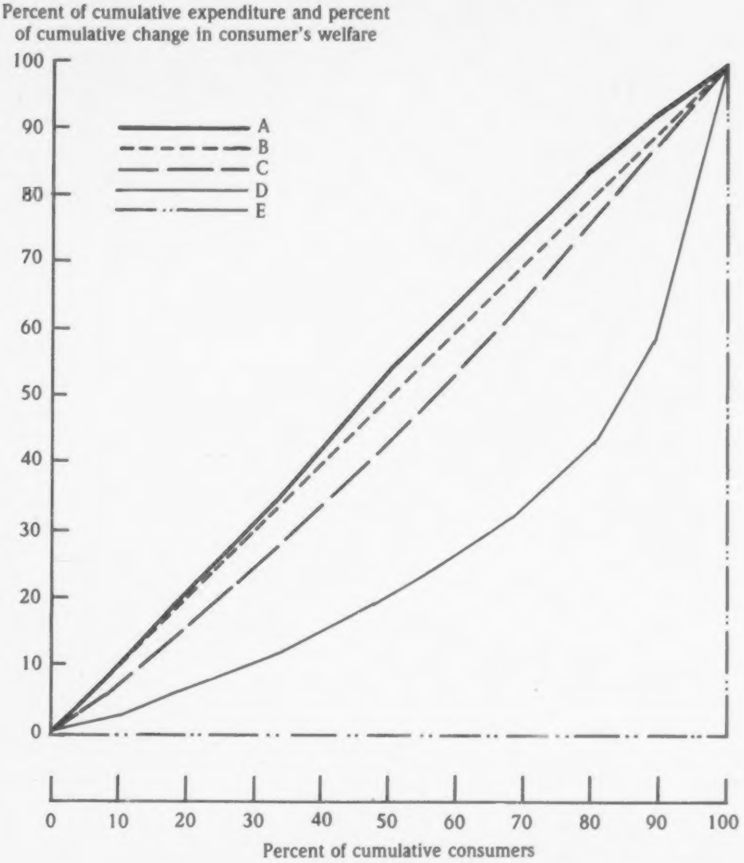
Household Expenditure Group	Calories Consumed[a]	Daily per Capita Increase in Calorie Consumption		
		Wheat Subsidy[b]	Rice Subsidy[b]	Percent of Increase from Wheat to Rice
(Cr $)				
Less than 4,500	1,447	10	16	60
4,500–8,999	1,812	12	25	108
9,000–11,299	1,832	20	27	85
11,300–15,799	1,877	26	27	4
15,800–22,599	1,909	24	27	13
22,600–31,599	2,008	19	26	37
31,600–45,199	2,132	6	23	283
45,200–67,799	2,164	6	22	267
More than 67,799	2,314	9	18	122

Sources: Calculated by the authors. Per capita calorie consumption is from Fundação Instituto Brasileiro de Geografia e Estatística, "Special Runs of ENDEF: Consumption in Calories by Global Income Classes," FIBGE, Rio de Janeiro, 1974 (mimeographed).

[a] This column is the actual per capita calorie consumption less the increase in calorie consumption due to the wheat consumption subsidy in effect in 1974.

[b] These columns were obtained from the model used in this chapter.

Figure 10—Consumers' welfare distribution



Notes: A = change in distribution of consumer welfare with rice subsidy; B = perfect equality; C = the change in distribution of consumer welfare with wheat subsidy; D = expenditure distribution; and E = inequality.

nontarget group—consumers above the third expenditure stratum—consumes a larger amount of the wheat or rice consumed. If the primary goals of subsidizing food consumption are to improve income distribution and the nutritional status of the poor, then rice is slightly better than wheat because the increase in calorie consumption for the rice subsidy is greater than that for the wheat subsidy. In the case of wheat, a general price subsidy is even more costly because the present wheat consumption policy directs the subsidy to the wheat grain that millers buy from the government. Pereira Soares reports that during the period 1967-77 millers appropriated approximately one-third of the value of the subsidy through manipulations in the production of special wheat flour and in the marketing of bran, which was not under strong government control.[32]

In the case of rice, even if there were

---

[32] Pereira Soares, *Avaliação Econômica da Política Triticola.*

better distributional characteristics (see Figure 10), a general price subsidy would be difficult to administer because of a lack of organizational structure.[33] If the government's real goals are a more equitable distribution of income and improvement in the nutritional status of the poor, which kind of program should the government undertake?

Some simple estimations of the costs of alternative consumption policies are presented in Appendix 3. However, this topic deserves a more careful analysis in future research.

---

[33] L. E. Carvalho, "Caráter Social de Política de Subsídio ao Trigo."

5

CONCLUSIONS

During the period 1966-82, the Brazilian government's sustained effort to achieve self-sufficiency in wheat production through a production policy that consisted of a guaranteed producer price keyed to the cost of producing wheat led to a producer price that was generally above border prices evaluated at official exchange rates and below border prices evaluated at shadow exchange rates. This policy, in terms of increased wheat production, showed positive results in 4 years and negative results in 13 others, compared with the levels of production if the free market had prevailed at the shadow exchange rate. Largely because the cruzeiro was persistently overvalued during this period, the producer subsidy in most cases only offset the tax from a distorted exchange rate.

Throughout the period, aggregate wheat consumption increased mainly as a consequence of the explicit general price subsidy, and, with the exception of seven years (1966-72), this increase was greater than the increases in wheat production when valued at the official exchange rate. As a whole, the explicit production subsidy was able to reduce net imports only during the seven years referred to above. The gains in production were small, especially after discounting for the increase in seed demand for the following year as a result of increases in area planted.

The wheat production policy for the whole period represented an estimated net subsidy of Cr$11.6 billion and an estimated net tax of Cr$15.3 billion in 1977 real cruzeiros, evaluated at official and shadow exchange rates respectively. This was due in part to the rise in the price of wheat in the world market in the mid- and late 1970s, at which time the domestic price set by the government fell short of the border price. In addition, the overvaluation of the cruzeiro represented a tax on producers.

The estimated social costs of the production policy for the whole period were Cr$2.1 billion at the official rate and Cr$2.9 billion at the shadow rate. The effects on foreign exchange induced by the production policy were estimated to be a savings of about Cr$5.0 billion at the official rate and an expenditure of Cr$16.4 billion at the shadow rate. This result was contrary to the stated objectives of the explicit production policy.

The total costs of the wheat consumption subsidies for the whole period were about Cr$84.0 billion and Cr$149.9 billion evaluated at official and shadow exchange rates respectively. Of this total, consumers captured a maximum of 86 percent. However, approximately one-third of the total subsidy was captured by the nontarget group, one-third was lost through the manipulations of the millers,[34] and social costs amounted to about 15 percent of the total cost. Thus, only about 19 percent of the total subsidy was captured by the true target group, the low-income consumers. Clearly, the wheat consumption subsidy is a poor program from the viewpoint of cost-effectiveness. This conclusion is reinforced by the results obtained through the alternative consumption policy analysis in Appendix 3, in which a general price subsidy for bread was ranked in third place and had a cost 4.5 to 7.4 times greater than that of a food stamp program.

In foreign exchange expenditure, the wheat consumption subsidy program cost Cr$29.7 billion in real 1977 cruzeiros evaluated at the official exchange rate and Cr$54.1 billion at the shadow. This level of expenditure was not in accord with the objective of achieving a saving in foreign exchange. The effects of the production and consumption policies together are the sum of individual effects of each policy.

---

[34] Pereira Soares, *Avaliação Econômica da Política Triticola.*

Based on the disaggregative analysis, one can conclude that, even though the gains in consumer welfare are slightly biased toward high-expenditure groups, the wheat consumption subsidy contributed to the income redistribution objective by distributing the benefits of the subsidy more equitably. When the subsidy costs for wheat were shifted to rice in a simulated general price subsidy, the distribution of the gains became slightly biased toward the low-expenditure groups. However, two main points should be made: first, even if a cut in the wheat consumption subsidy (or the simulated rice subsidy) harms the low- and medium-expenditure groups more, the drop in real expenditure is small (less than 2 percent). Second, the effect on nutrition was slight—less than 1.5 percent of the total per capita energy intake.

Finally, based on cases studied in the alternative consumption policy analysis (Appendix 3), one can conclude that the wheat consumption subsidy is not a good policy for redistributing income, nor is it a good instrument for dealing with malnutrition. The alternative consumption policy analysis shows that if food consumption is to be subsidized, the subsidy should be through a target-oriented program, such as food stamps.

Many of the parameters used in this analysis came from secondary sources. In some cases they were estimated for a period of time other than that of the study and under somewhat different conditions. The results could be improved with updated estimates of parameters for aggregate supply and demand, disaggregate demand by income groups, shadow prices of foreign exchange, and individual intake of wheat products by income groups.

Once estimates of the parameters of the aggregate demand and supply curves and of the disaggregated demand curves are obtained, it will be possible to develop a new set of formulas to calculate the policy measures derived in this study, thus relaxing the assumption of constant demand and supply parameters. Relaxing that assumption would bring more realism to the analysis.

The production policy analysis could also be extended to account for the net effect of all policies that affect wheat production in each year. Such an analysis could be performed by making use of the theory of effective protection.

In addition, it would be interesting to expand the analysis of the alternative consumption policies to consider the products that are the best candidates for subsidizing in each typical macroregion of Brazil, considering the tastes and preferences of the target groups. Moreover, estimates and comparisons of the administrative costs of target-oriented programs and country-wide programs would be of interest.

Finally, a plan could be developed to phase out both subsidies—production and consumption—in order to minimize the negative effects on wheat growers and low-income consumers.

APPENDIX 1:

SUPPLEMENTARY TABLES

Data Set for the Aggregative Analysis

Table 16—Current wheat prices, 1965-82

Year	Producer Price	Miller Price	Import Price (c.i.f.)
		(Cr $/metric ton)	
1965	210	157	138
1966	265	180	158
1967	317	218	197
1968	383	273	235
1969	450	311	281
1970	490	402	300
1971	547	456	385
1972	600	511	466
1973	750	573	784
1974	1,400	713	1,478
1975	1,670	734	1,380
1976	2,130	766	1,702
1977	3,170	1,202	1,574
1978	4,150	1,432	2,506
1979	5,400	1,563	4,644
1980	11,840	2,206	11,654
1981	28,500	9,918	20,550
1982	58,823	23,921	36,051

Sources: Banco do Brasil, "Trigo Nacional," Departamento de Comercialização do Trigo Nacional, Pôrto Alegre, RS, December 1979; Banco do Brasil, "Preços de Trigo para os Produtores e Volume de Produção," Departamento de Comercialização, do Trigo Nacional, Pôrto Alegre, RS, 1984 (mimeographed); Brazil, National Supply Superintendency, Departamento do Trigo, "Evolução do Preço do Trigo em Grão para Produtores e Moinhos e Consumo Aparente de Farinha de Trigo," SUNAB, Rio de Janeiro, 1983 (mimeographed); and Fundação Instituto Brasileiro de Geografia e Estatística, *Anuário Estatístico do Brasil* (Rio de Janeiro: FIBGE, various years).

Note: The c.i.f. price was obtained by dividing the total c.i.f. value of wheat grain imports by the quantity imported.

Table 17—Total production, seed consumption, consumption by millers, and imports of wheat, 1965-82

Year	Production	Seeds	Consumption	Imports
		(metric tons)		
1965	221,576	17,602	...	2,380,659
1966	298,523	29,076	2,488,062	2,394,408
1967	364,870	47,661	2,404,039	2,446,017
1968	693,598	71,911	2,884,158	2,621,013
1969	1,146,319	117,155	2,907,855	2,355,599
1970	1,734,972	166,159	3,033,611	1,969,300
1971	2,038,632	224,831	3,209,356	1,710,521
1972	693,399	152,467	3,377,669	1,796,877
1973	1,934,439	219,351	3,797,636	2,945,548
1974	2,848,040	279,257	4,116,482	2,399,175
1975	1,582,587	344,575	4,437,274	2,082,376
1976	3,037,864	328,237	5,064,250	3,425,999
1977	2,012,842	382,699	5,252,116	2,608,068
1978	2,700,707	483,403	5,656,178	4,334,432
1979	2,881,186	402,889	6,096,512	3,650,741
1980	2,702,130	315,177	6,802,036	4,755,116
1981	2,223,632	388,272	6,097,950	4,360,034
1982	1,802,337	403,365	6,101,072	4,144,000

Sources: Banco do Brasil, "Trigo Nacional," Departamento de Comercialização do Trigo Nacional, Pôrto Alegre, RS, December 1979; Banco do Brasil, "Preços de Trigo para os Produtores e Volume de Produção," Departamento de Comercialização do Trigo Nacional, Pôrto Alegre, RS 1984 (mimeographed); Brazil, National Supply Superintendency, Departamento do Trigo, "Evolução do Preço do Trigo em Grão para Produtores e Moinhos e Consumo Aparente de Farinha de Trigo," SUNAB, Rio de Janeiro, 1983 (mimeographed); and Fundação Instituto Brasileiro de Geografia e Estatística, *Anuário Estatístico dc Brasil* (Rio de Janeiro: FIBGE, various years).

Table 18—Miscellaneous data for the aggregative analysis of Brazilian wheat policy, 1965-82

Year	General Price Index, Annual Average	General Price Index, November 1977	Nominal Exchange Rate	Shadow Price Exchange Rate	Port to Mill Expenses as Percent of c.i.f. Prices[a]	Farm to Mill Expenses as Percent of Farmgate Prices[b]
	(1977 = 100)		(Cr $/U.S. $)			
1965	5.8	6.4	1.90	2.70	0.15	0.09
1966	8.1	8.9	2.22	3.90	0.15	0.09
1967	10.4	11.1	2.67	4.90	0.15	0.11
1968	12.9	13.9	3.38	5.70	0.15	0.14
1969	15.5	16.8	4.08	6.50	0.15	0.16
1970	18.6	19.9	4.59	7.30	0.15	0.20
1971	22.4	23.8	5.29	7.30	0.15	0.20
1972	26.2	27.6	5.93	8.20	0.15	0.19
1973	30.2	31.8	6.13	8.30	0.15	0.16
1974	38.8	42.3	6.79	9.00	0.15	0.16
1975	49.6	54.7	8.19	10.70	0.15	0.11
1976	70.1	79.9	10.67	14.30	0.15	0.13
1977	100.0	111.0	14.14	19.00	0.18	0.19
1978	138.7	157.3	18.07	24.00	0.16	0.20
1979	213.5	263.7	26.85	33.60	0.14	0.22
1980	427.5	561.8	52.71	61.50	0.13	0.15
1981	897.3	1,118.8	93.12	120.10	0.13	0.15
1982	1,753.7	2,185.2	179.51	228.20	0.14	0.16

(continued)

Table 18—Continued

Notes and Sources: The price elasticity of demand for wheat grain for the whole period was −0.25 and that for supply was 0.75 (A. Rojko et al., *Alternative Futures for World Food in 1985,* Foreign Agricultural Economics Report No. 14 [Washington, D.C.: U.S. Department of Agriculture, 1978]). The general price index is from Fundação Getúlio Vargas, *Conjunctura Econômica,* various issues. The nominal exchange rate is from the International Monetary Fund, *International Financial Statistics* (Washington, D.C.: IMF, 1983). The shadow price of the exchange rate was calculated by the authors for each year, based on the shadow price of foreign exchange estimated by the World Bank at Cr$61.50 per U.S.$1.00 for the year 1980 (World Bank, *Brazil: Industrial Policies and Manufactured Exports* (Washington, D.C.: World Bank, 1981], Annex 2). The authors' estimate was made on the basis of the purchasing power parity method (data set and methodology are available from Geraldo Calegar upon request).

[a] Because data on port-to-mill expenses are not available for the years 1965-75, a simple average from 1976-82 is used here. Data for the latter years are found in Commission for Production Financing, "Preços e Custos Domésticos Internacionais Distorções, Um Estudos Preliminar," Au[illegible]83 (mimeographed).

[b] Farm-to-mill expenses are calculated from Banco do Brasil, "Farm [illegible] Expenses," Departamento de Comercialização do Trigo Nacional, Pôrto Alegre, RS, 1983 (mimeographed).

Table 19—Estimated production and consumption subsidies, evaluated at official and shadow prices of foreign exchange, 1965-82

	Production Subsidy[a]		Consumption Subsidy[b]	
Year	Official Exchange Rate	Shadow Exchange Rate	Official Exchange Rate	Shadow Exchange Rate
		(percent)		
1965	55.0	−8.0	1.1	30.4
1966	45.5	−17.6	0.9	43.6
1967	45.8	−20.7	3.8	47.6
1968	49.7	−11.1	−1.0	40.1
1969	49.4	−6.5	3.8	39.6
1970	59.3	0.2	−16.5	26.7
1971	40.0	1.1	−3.0	25.4
1972	26.4	−8.5	4.6	31.1
1973	−8.2	−32.3	36.4	53.1
1974	−12.4	−33.9	58.0	68.4
1975	5.8	−18.9	53.8	64.6
1976	8.2	−19.5	60.9	70.8
1977	83.5	36.2	35.3	51.8
1978	51.1	15.8	50.8	63.2
1979	0.5	−19.5	70.5	76.4
1980	−21.7	−32.6	83.2	85.6
1981	13.6	−12.3	57.3	66.9
1982	32.7	4.8	41.8	54.2

Source: Calculated by the authors.

[a] Nominal rate of protection for producers.

[b] Nominal rate of protection for consumers.

Table 20—Estimated effects of wheat production and consumption policies on quantities produced, consumed, and imported, based on the official exchange rate, 1966-82

Year	Change in Production in Year t−1[a]	Percent[b]	Partial Change in Imports in Year t[c]	Percent[b]	Consumption in Year t	Percent[b]	Total Change in Imports in Year t[d]	Percent[b]
	(1,000 metric tons)		(1,000 metric tons)		(1,000 metric tons)		(1,000 metric tons)	
1966	40.3	15.5	−33.3	−1.4	5.9	0.2	−27.4	−1.1
1967	72.3	22.9	−60.6	−2.4	23.1	1.0	−37.6	−1.5
1968	89.5	15.1	−70.6	−2.6	−7.2	−0.3	−77.8	−2.9
1969	181.7	18.4	−151.4	−6.1	27.9	1.0	−123.5	−5.0
1970	296.4	20.4	−247.5	−10.6	−118.1	−3.8	−365.6	−15.7
1971	511.5	28.5	−461.8	−21.0	−23.9	−0.7	−485.7	−22.1
1972	450.7	71.1	−426.1	−19.5	40.1	1.2	−386.0	−17.7
1973	112.0	5.6	−126.8	−4.8	407.0	12.0	280.2	10.5
1974	−130.8	−4.4	101.7	6.8	803.4	24.3	905.1	60.6
1975	−296.4	−19.1	310.9	31.3	777.9	21.3	1,088.8	109.6
1976	66.8	2.3	−48.7	−2.0	1,058.7	26.4	1,009.8	41.8
1977	167.9	10.5	−28.4	−1.4	541.4	11.5	513.0	24.5
1978	733.3	31.2	−617.8	−15.3	918.1	19.4	300.3	7.4
1979	757.6	26.4	−755.5	−27.0	1,602.8	35.7	847.3	30.2
1980	15.8	0.1	−77.9	−3.3	2,450.5	56.3	2,372.6	99.6
1981	−532.1	−25.0	566.5	21.6	1,168.6	23.7	1,735.2	66.1
1982	197.2	12.2	−119.1	−3.4	772.1	14.5	653.0	18.7

Source: Calculated by the authors.

[a] The production of year t − 1 is consumed in year t.

[b] The percentages represent the degree of difference in production, consumption, and imports that would have been observed if world prices had prevailed.

[c] The partial change in imports in year t is the result of the production subsidy in year t − 1 alone. It is given by $\{-CQP_{t-1} - [QP_{t-1} - (SP_t - SW_t)]\}$, where CQP is the change in quantity produced, QP is the quantity produced at the subsidized price, SP is the quantity of seeds used at the subsidized producer price, and SW is the quantity of seeds used if the world price had prevailed.

[d] The total change in imports includes the effects of both producer and consumer subsidies.

Table 21—Estimated effects of wheat production and consumption policies on quantities produced, consumed, and imported based on the shadow exchange rate, 1966-82

Year	Change in Production in Year t−1[a]	Percent[b]	Partial Change in Imports in Year t[c]	Percent[b]	Consumption in Year t	Percent[b]	Total Change in Imports in Year t[d]	Percent[b]
	(1,000 metric tons)		(1,000 metric tons)		(1,000 metric tons)		(1,000 metric tons)	
1966	−14.3	−4.1	9.8	0.5	332.0	15.4	341.8	16.7
1967	−46.7	−10.8	37.7	1.8	358.4	17.5	396.1	19.3
1968	−69.3	−9.1	62.7	2.8	346.9	13.7	409.6	18.5
1969	−63.9	−5.3	57.9	3.0	344.4	13.4	402.3	20.6
1970	−58.8	−3.4	59.0	3.5	227.1	8.1	286.1	17.0
1971	2.2	0.1	−0.4	−0.03	226.3	7.6	225.9	15.2
1972	16.9	2.3	−27.4	−1.8	299.9	9.7	272.5	17.9
1973	−48.0	−1.9	−26.6	−1.2	654.4	20.8	627.8	27.1
1974	−657.9	−16.9	556.3	68.3	1,028.8	33.3	1,585.1	194.7
1975	−1,036.3	−55.9	977.6	1,082.6	1,014.5	29.6	1,992.1	2,206.1
1976	−269.7	−7.5	211.7	11.3	1,431.3	36.0	1,552.0	82.8
1977	−537.0	−33.6	616.1	55.6	876.8	20.0	1,492.9	133.9
1978	415.9	16.3	−365.5	10.6	1,251.8	28.4	886.3	25.7
1979	281.7	8.3	−352.9	−16.4	1,847.8	43.5	1,494.9	69.3
1980	−509.0	−14.0	400.7	23.0	2,615.1	62.5	3,015.8	173.4
1981	−928.7	−37.9	888.7	44.5	1,472.4	31.8	2,361.1	118.1
1982	−228.9	−13.2	242.9	8.6	1,082.4	21.6	1,325.3	47.0

Source: Calculated by the authors.

[a] The production of year t − 1 is consumed in year t.

[b] The percentages represent the degree of difference in production, consumption, and imports that would have been observed if world prices had prevailed.

[c] The partial change in imports in year t is the result of the production subsidy in year t − 1 alone. It is given by $\{-CQP_{t-1} - [QP_{t-1} - (SP_t - SW_t)]\}$, where CQP is the change in quantity produced, QP is the quantity produced at the subsidized price, SP is the quantity of seeds used at the subsidized producer price, and SW is the quantity of seeds used if the world price had prevailed.

[d] The total change in imports includes the effects of both producer and consumer subsidies.

Table 22—Estimated effects of the production policy, based on the official exchange rate, 1966-82

	Total Subsidy (Tax) Cost (TC)		Change in Producers' Welfare		Social Cost (SC)		Effect on Foreign Exchange (EF)		
Year	Cr$ Million	Percent	Cr$ Million	Percent of TC	Cr$ Million	Percent of TC	Cr$ Million	Percent[a]	Ratio of SC to EF
1966	299.4	100	263.7	88.1	35.7	11.9	162.1	2.9	0.22
1967	362.0	100	318.2	87.9	43.8	12.1	195.0	3.5	0.22
1968	725.5	100	632.1	87.1	93.4	12.9	380.6	6.5	0.25
1969	1,171.5	100	1,022.6	87.3	148.9	12.7	618.0	11.2	0.24
1970	1,908.5	100	1,632.6	85.5	275.9	14.5	948.6	20.6	0.29
1971	1,592.2	100	1,418.7	89.1	173.5	10.9	890.6	20.8	0.19
1972	375.8	100	345.7	92.0	30.1	8.0	229.2	5.9	0.13
1973	−481.7	100	−498.0	103.4	16.3	3.4	−389.8	−4.8	0.04
1974	−1,546.5	100	−1,627.6	105.2	81.1	5.2	−1,301.8	−14.1	0.06
1975	299.1	100	292.8	97.9	6.3	2.1	213.3	3.1	0.03
1976	668.3	100	649.9	97.2	18.4	2.8	469.0	4.7	0.04
1977	3,101.8	100	2,550.8	82.2	551.0	17.8	1,362.0	21.9	0.40
1978	2,679.1	100	2,363.9	88.2	315.2	11.8	1,457.7	13.0	0.22
1979	51.9	100	51.7	99.6	0.2	0.4	38.7	0.4	0.01
1980	−1,772.6	100	−1,948.7	109.9	176.1	9.9	−1,637.7	−12.6	0.11
1981	758.3	100	724.8	95.6	33.5	4.4	510.2	4.3	0.07
1982	1,404.0	100	1,269.7	90.4	134.3	9.6	818.0	7.8	0.16
Total	11,596.6	100	9,462.9	81.6	2,133.7	18.4	4,963.7	3.7	0.43

Source: Calculated by the authors.
Note: Cr$ million are in real 1977 cruzeiros.
[a] Percent = EF · 100/(total cost of wheat imports + EF).

Table 23—Estimated effects of the production policy, based on the shadow exchange rate, 1966-82

	Total Subsidy (Tax) Cost (TC)		Change in Producers' Welfare		Social Cost (SC)		Effect on Foreign Exchange (EF)		
Year	Cr$ Million	Percent	Cr$ Million	Percent of TC	Cr$ Million	Percent of TC	Cr$ Million	Percent[a]	Ratio of SC to EF
1966	−207.5	100	−223.9	−107.9	16.4	7.9	−184.3	−2.0	0.09
1967	−302.1	100	−331.1	−109.6	29.0	9.6	−277.3	−2.9	0.10
1968	−271.9	100	−284.5	−104.6	12.6	4.6	−226.0	−2.5	0.06
1969	−245.3	100	−251.6	102.6	6.3	2.6	−195.0	−2.6	0.03
1970	8.7	100	8.7	100.0	0.0	0.0	6.5	0.1	0.00
1971	61.2	100	60.9	99.5	0.3	0.5	45.4	1.0	0.00
1972	−167.1	100	−172.9	103.5	5.8	3.5	−135.5	−2.7	0.04
1973	−2,526.4	100	−2,962.8	117.3	436.4	17.3	−2,658.6	−28.8	0.16
1974	−5,604.9	100	−6,642.7	118.5	1,037.8	13.5	−6,019.8	−76.1	0.17
1975	−1,251.8	100	−1,359.4	108.6	107.6	8.6	−1,127.1	−14.9	0.10
1976	−2,217.6	100	−2,415.4	108.9	197.8	8.9	−2,009.3	−18.6	0.10
1977	1,815.6	100	1,630.5	89.8	185.1	10.2	1,037.8	13.8	0.18
1978	1,199.1	100	1,137.0	94.8	62.1	5.2	790.6	6.1	0.08
1979	−1,743.1	100	−1,898.5	108.9	155.4	8.9	−1,579.2	−16.2	0.10
1980	−3,161.5	100	−3,713.6	117.5	552.1	17.5	−3,337.3	−24.3	0.17
1981	−909.5	100	−956.6	105.2	47.1	5.2	−764.5	−5.5	0.06
1982	259.5	100	255.0	98.3	4.5	1.7	186.8	1.5	0.02
Total	−15,264.6	100	−18,120.9	118.7	2,856.3	18.7	−16,446.8	−10.5	0.17

Source: Calculated by the authors.
Note: Cr$ million are in real 1977 cruzeiros.
[a] Percent = EF · 100/(total cost of wheat imports + EF).

Table 24—Estimated effects of the consumption policy, based on the official exchange rate, 1966-82

Year	Total Subsidy (Tax) Cost (TC)		Change in Consumers' Welfare		Social Cost (SC)		Effect on Foreign Exchange (EF)		Ratio of SC to EF
	Cr$ Million	Percent	Cr$ Million	Percent of TC	Cr$ Million	Percent of TC	Cr$ Million	Percent[a]	
1966	52.2	100	52.1	99.8	0.1	0.2	−13.1	0.24	0.01
1967	197.1	100	196.2	99.5	0.9	0.5	−50.0	0.95	0.02
1968	−60.6	100	−60.7	100.2	0.1	0.2	15.1	0.27	0.01
1969	229.7	100	228.6	99.5	1.1	0.5	−58.3	1.20	0.02
1970	−928.3	100	−945.8	101.9	17.5	1.9	219.0	5.66	0.08
1971	−189.4	100	−190.0	100.3	0.6	0.3	46.8	1.37	0.01
1972	[illegible]0.9	100	319.0	99.4	1.9	0.6	−81.7	2.27	0.02
1973	4,[illegible]1.8	100	3,889.6	94.1	242.2	5.9	−1,214.6	16.03	0.20
1974	10,468.2	100	9,264.1	88.5	1,204.1	11.5	−3,520.1	50.35	0.34
1975	7,632.1	100	6,856.7	89.8	775.4	10.2	−2,489.6	59.65	0.31
1976	8,604.2	100	7,532.0	87.5	1,072.2	12.5	−2,955.1	44.70	0.36
1977	3,440.1	100	3,246.9	94.4	193.2	5.6	−1,005.0	26.18	0.19
1978	6,940.1	100	6,223.3	89.7	716.8	10.3	−2,272.7	30.23	0.32
1979	10,656.7	100	8,908.7	83.4	1,748.0	16.6	−3,975.2	78.27	0.44
1980	17,440.4	100	13,191.4	75.6	4,249.0	24.4	−7,546.9	106.31	0.56
1981	9,043.4	100	8,025.0	88.7	1,018.4	11.3	−3,024.5	36.62	0.34
1982	5,979.1	100	5,558.1	93.0	420.0	7.0	−1,810.5	22.91	0.23
Total	83,957.7	100	72,295.2	86.1	11,661.5	13.9	−29,736.4	30.68	0.39

Source: Calculated by the authors.
Note: Cr$ million are in real 1977 cruzeiros.
[a] Percent = EF · 100/(total cost of wheat imports + EF).

Table 25—Estimated effects of the consumption policy, based on the shadow exchange rate, 1966-82

Year	Total Subsidy (Tax) Cost (TC)		Change in Consumers' Welfare		Social Cost (SC)		Effect on Foreign Exchange (EF)		Ratio of SC to EF
	Cr$ Million	Percent	Cr$ Million	Percent of TC	Cr$ Million	Percent of TC	Cr$ Million	Percent[a] of TC	
1966	4,277.0	100	3,957.7	92.5	319.3	7.5	−1,308.7	16.1	0.24
1967	4,572.5	100	4,186.1	91.6	386.4	8.4	−1,432.9	17.2	0.27
1968	4,086.9	100	3,814.9	93.3	272.0	6.7	−1,225.7	15.3	0.22
1969	3,823.8	100	3,573.8	93.5	250.0	6.5	−1,143.5	17.1	0.22
1970	2,393.5	100	2,298.1	96.0	95.4	4.0	−669.9	13.0	0.14
1971	2,220.9	100	2,137.8	96.3	83.1	3.7	−617.5	15.3	0.13
1972	2,965.6	100	2,823.8	95.2	141.8	4.8	−847.7	20.0	0.17
1973	8,145.9	100	7,334.6	90.0	811.3	10.0	−2,645.0	28.6	0.31
1974	16,334.2	100	13,815.2	84.6	2,519.0	5.4	−5,972.8	75.1	0.42
1975	11,980.6	100	10,320.5	86.1	1,660.1	13.9	−4,240.3	95.0	0.39
1976	13,415.2	100	11,195.0	83.5	2,220.2	16.5	−5,018.9	64.3	0.44
1977	6,796.7	100	6,143.3	90.4	653.4	9.6	−2,188.7	50.6	0.30
1978	10,039.7	100	8,701.1	86.7	1,338.6	13.3	−3,513.9	40.6	0.38
1979	14,454.8	100	11,628.4	80.5	2,826.4	19.5	−5,733.5	102.5	0.49
1980	20,963.7	100	15,384.5	73.5	5,552.2	26.5	−9,398.3	122.2	0.59
1981	13,616.7	100	11,602.0	85.2	2,014.7	14.8	−4,915.2	51.0	0.41
1982	9,853.2	100	8,838.5	89.7	1,014.7	10.3	−3,224.4	35.4	0.31
Total	149,913.9	100	127,755.3	85.2	22,158.6	14.8	−54,096.9	45.4	0.41

Source: Calculated by the authors.
Note: Cr$ million are in real 1977 cruzeiros.
[a] Percent = EF · 100/(total cost of wheat imports + EF).

Data Set for the Disaggregative Analysis

Table 26—Annual per capita expenditures on wheat products and rice, by expenditure group, metropolitan area of Belo Horizonte and rural areas of Minas Gerais and Espírito Santo, 1974/75

Expenditure Group	Wheat Bread and Crackers	Macaroni	Wheat Flour	Rice
		(Cr$)		
Metropolitan area				
Less than 4,500	30	25	2	70
4,500–8,999	37	20	1	105
9,000–11,299	57	28	2	154
11,300–15,799	62	23	2	144
15,800–22,599	82	27	2	164
22,600–31,599	137	33	5	143
31,600–45,199	170	30	5	132
45,200–67,799	150	28	5	154
More than 67,799	189	30	10	131
Rural areas				
Less than 2,300	2	6	0	39
2,300–3,399	6	12	1	77
3,400–4,499	6	11	2	93
4,500–6,799	9	16	2	112
6,800–8,999	15	20	3	159
9,000–15,799	18	18	7	163
15,800–22,599	25	25	10	190
22,600–31,599	35	22	12	221
More than 31,599	61	29	14	265

Source: Fundação Instituto Brasileiro de Geografia e Estatística, *Estudo Nacional da Despesa Familiar: Despesas das Famílias, Dados Preliminares*, 6 vols. (Rio de Janeiro: FIBGE, 1978 and 1979).

Note: Wheat products include bread and crackers, macaroni, and wheat flour.

Table 27—Energy consumption from wheat products and rice per consumer per day, metropolitan area of Belo Horizonte and rural areas of Minas Gerais and Espírito Santo, 1974/75

Expenditure Group	Wheat Bread and Crackers	Macaroni	Wheat Flour	Rice
		(kilocalories/consumer/day)		
Metropolitan area				
Less than 4,500	73	109	7	274
4,500–8,999	107	83	6	435
9,000–11,299	132	94	10	465
11,300–15,799	152	84	11	470
15,800–22,599	166	79	12	475
22,600–31,599	199	79	19	453
31,600–45,199	252	69	18	412
45,200–67,799	265	53	20	386
More than 67,799	274	48	34	321
Rural areas				
Less than 2,300	4	28	1	186
2,300–3,399	13	42	2	272
3,400–4,499	13	52	10	337
4,500–6,799	17	60	14	410
6,800–8,999	25	65	14	465
9,000–15,799	32	61	30	551
15,800–22,599	37	79	45	557
22,600–31,599	58	69	42	660
More than 31,599	71	70	50	663

Source: Fundação Instituto Brasileiro de Geografia e Estatística, "Special Runs of ENDEF: Consumption in Calories by Global Income Classes," FIBGE, Rio de Janeiro, n.d. (mimeographed).

Note: Wheat products include bread and crackers, macaroni, and wheat flour.

Table 28—Data for derivation of expenditures and changes in consumer welfare curves, Belo Horizonte, 1974/75

Household Expenditure Group	Per Capita Expenditure	Number of Consumers	Total Expenditure
(Cr$)	(Cr$)	(1,000)	(Cr$1,000)
Less than 4,500	1,604	22	37,102
4,500–8,999	1,749	184	321,816
9,000–11,299	2,549	128	326,272
11,300–15,999	2,692	275	740,300
16,000–22,599	3,793	320	1,213,760
22,600–31,599	4,453	300	1,335,900
31,600–45,199	5,919	240	1,420,560
45,200–67,799	10,869	155	1,684,695
More than 67,799	27,494	190	5,223,860
Total	. . .	1,814	12,304,265

Source: Fundação Instituto Brasileiro de Geografia e Estatística, *Estudo Nacional da Despesa Familiar: Despesas das Famílias, Dados Preliminares,* 6 vols. (Rio de Janeiro: FIBGE, 1978).

Note: Total expenditure is the per capita expenditure times the number of consumers.

APPENDIX 2:
A SIMPLE MODEL FOR ANALYZING THE EFFECTS OF SHIFTING THE SUBSIDY FROM WHEAT TO RICE

When the market for rice in Belo Horizonte is viewed as an undistorted market (that is, without government intervention), it can be depicted in equilibrium at price P_0 and quantity Q_0, according to Figure 11. DD is the demand for rice and SS is the supply of rice. It is assumed that SS is infinitely elastic because the Belo Horizonte market is a relatively small fraction of the Brazilian market. To determine the effect on the price of rice of transferring the consumption subsidy from wheat to rice, in order to use the methodology in Chapter 4 to evaluate the distributional effects of that transfer, the following equations related to Figure 11 must be solved:

$$(P_0 - P_1)Q_1 = TCS, \qquad (36)$$

$$Q_0 = aP_0^{-\eta}, \text{ and} \qquad (37)$$

$$Q_1 = aP_1^{-\eta}, \qquad (38)$$

where

P_0 and Q_0 = the equilibrium free market price and quantity;

P_1 and Q_1 = the postsubsidy equilibrium price and quantity;

TCS = the total cost of the subsidy of wheat transferred to rice, that is, area P_0 ABP P_1 in Figure 11;

a = the demand shifter; and

η = the price elasticity of demand for rice in Belo Horizonte.

As can be seen, the demand function is assumed to be of constant elasticity.

In the system above, the values for P_0, Q_0, and TCS have been estimated from secondary sources, as shown in the table below.

	Estimate
P_0	Cr\$3.25/kg
Q_0	377 kg/year
η	−0.13
TCS	Cr\$402.00/year
P_1	Cr\$2.23/kg

Here P_0 is an average price per kilogram paid by consumers in the metropolitan area of Belo Horizonte in August 1974, calculated by dividing the annual per capita expenditures on rice[35] by the annual per capita consumption of rice,[36] after converting to kilograms, considering that 1 kilogram = 3,570 calories.[37]

Q_0 is the average quantity used (41.9 kilograms per year) multiplied by nine, which is an average of the nine expenditure strata. η is an average from estimates made by Paniago and Mandell for Brazil.[38] TCS, the total cost of the subsidy, is obtained from Table 12. It is a summation of all nine figures of the third column. Finally, P_1 is obtained from the solution of equation (39) below.

After substituting the known variables above into the system defined earlier and solving for P_1, the following equation is obtained:

$$377 \cdot (3.25)^{1.13} \cdot (P_1)^{-0.13} - 377 \cdot (3.25)^{0.13} \cdot (P_1)^{0.87} - 402 = 0. \qquad (39)$$

---

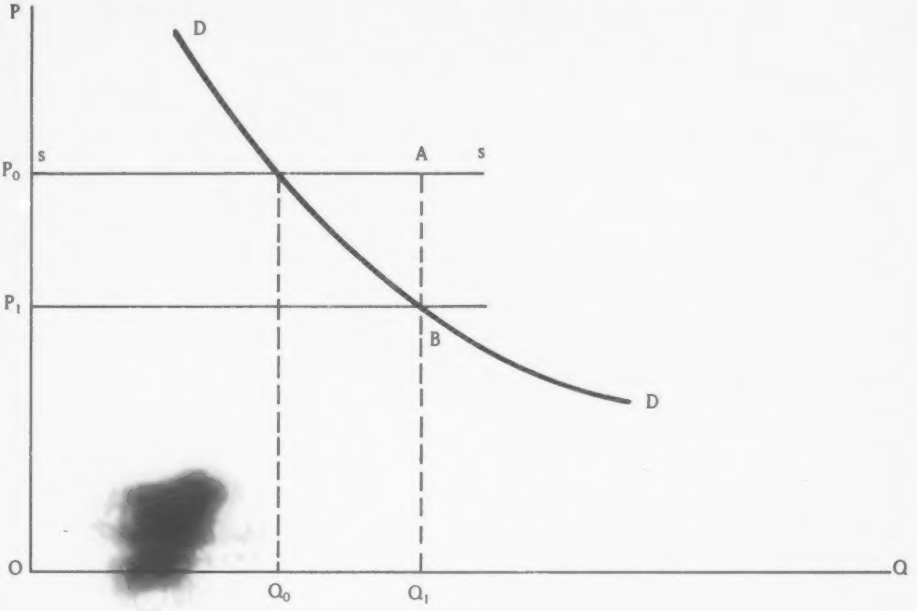
[35] Fundação Instituto Brasileiro de Geografia e Estatística, *Estudo Nacional da Despesa Familiar: Despesas das Famílias, Dados Praliminares,* 6 vols. (Rio de Janeiro: FIBGE, 1978) Region 4, p. 65, first column.

[36] Fundação Instituto Brasileiro de Geografia e Estatística, "Special Runs of ENDEF: Consumption in Calories by Global Income Classes," Rio de Janeiro, n.d., Region 4, p. 29 (mimeographed).

[37] Fundação Instituto Brasileiro de Geografia e Estatística, *Estudo Nacional de Despesa Familiar: Tabelas de Composição de Alimentos,* 2nd edition (Rio de Janeiro: FIBGE, 1981), p. 22.

[38] Euler Paniago, "An Evaluation of Agricultural Price Policies for Selected Food Products: Brazil," (Ph.D. dissertation, Purdue University, 1969); and P. I. Mandell, "A Expansão da Moderna Rizicultura: Crescimento de Oferta numo Economía Dinâmica," *Revista Brasileira de Economía* 26 (July/September 1972): 169-236.

Figure 11—Retail market for rice in Belo Horizonte


P
D
s
A
s
P_0
P_1
B
D
O
Q_0
Q_1
Q

APPENDIX 3:
ALTERNATIVE CONSUMPTION POLICIES: A MODEL AND SOME RESULTS

Among the many questions to be answered before any policy option is chosen, questions of fiscal cost and cost-effectiveness are perhaps the most important if one considers that public resources are scarce and therefore must be allocated as efficiently as possible. In this appendix, a simple model suggested by Reutlinger and Selowsky is presented to estimate the fiscal cost and cost-effectiveness of three basic policy options for improving the nutritional status of target groups in any society.[39]

Two large typologies of policies are identified for study: country-wide and target-group-oriented programs. In the first case, all segments of society benefit in the process of benefiting the target or deficient group; in the second case, only the target group receives the benefits. In other words, there is no spillover effect. The country-wide policy to be considered is a general price subsidy, whereas the target-oriented programs include a food stamp program and a price subsidy.

The Model

Under the assumption that the policy objective is to increase the consumption of a specific food in the target group by a fraction λ of the initial consumption of that food item by the target group, let α represent the share of consumption of that food by the target group (in the present case a low-income group).

If there are only two consumer groups, the target or low-income group (p), and the remaining, or richer group (r), with respective price elasticities of demand for the food item, η_p and η_r, one can define η_t as

$$\eta_p + (1 - \alpha)\eta_r,$$

where η_t is the total demand price elasticity for the commodity, expressed as the weighted average of the demand elasticities of both groups in absolute values.

First, an expression is derived to compute the fiscal cost (FC) of a general price subsidy, taking into account the policy objective defined above and the parameters of supply and demand for the target group or the whole population whenever necessary. Departing from the definitions of supply and demand elasticities and considering the market equilibrium after the general price subsidy has been instituted, two equations are obtained of the form:

$$\eta_p = (dq/dp^d)(P_o/q_o)$$

$$+ \, dp^d = \lambda/\eta_p, \text{ and} \qquad (40)$$

$$\eta_t dp^d = \varepsilon_t dp^s + dp^s = (\eta_t/\varepsilon_t)\, dp^d, \qquad (41)$$

where

q_o = the quantity of the commodity consumed by the target group, or αQ_o, where Q_o is the total consumption of the aggregated consumers;

dp^d, dp^s = percent of changes in the demand and supply prices, respectively;

ε_t = elasticity of total supply for the commodity; and

λ = dq/qo.

Substituting equation (40) into equation (41) gives

$$dp^s = (\eta_t/\eta_p)(\lambda/\varepsilon_t)P_o. \qquad (42)$$

With FC as the fiscal cost of the general price subsidy under consideration, the equation can be written:

---

[39] Shlomo Reutlinger and Marcelo Selowski, *Malnutrition and Poverty: Magnitude and Policy Options* (Baltimore: Johns Hopkins University Press for the World Bank, 1976).

$$FC_G = (dp^d + dp^s)$$
$$[Q_o + \eta_t dp^d (Q_o/P_o)], \qquad (43)$$

which, after substituting equations (41) and (42) into (43), becomes

$$FC_G = P_oQ_o(\lambda/\eta_p)[1 + (\eta_t/\varepsilon_t)]$$
$$[1 + \lambda(\eta_t/\eta_p)]. \qquad (44)$$

If $\varepsilon_t \rightarrow \infty$, the product could have an infinitely elastic supply curve (which could be the case if it is an imported product for which the country is a small buyer in the world market), then equation (44) becomes

$$FC_G = P_oQ_o(\lambda/\eta_p)[1 + \lambda(\eta_t/\varepsilon_p)]. \qquad (45)$$

In order to obtain the unitary cost of the general price consumption subsidy, UC_G (the cost incurred by the government for each additional unit of the consumption good by the target group), it is only necessary to divide equations (44) and (45) by dq (the total increase in consumption of the good by the target group with respect to the initial consumption level of the target group) as follows:

$$UC_G = (FC_G/\lambda\alpha Q_o). \qquad (46)$$

In order to derive expressions for the fiscal cost and the unitary cost of target-oriented programs using the same set of parameters as above, one must depart from Figure 12. Figure 12 represents the market for a food product that is relevant for the low-income target group, where D_p represents the demand by the group as a function of initial income Y, and S_p represents the excess supply faced by the target group. Therefore, $S_p = S_t - D_r$, where S_t and D_r are the total supply and demand of the non-target (upper-income) group.

Initial consumption and price are q_o and P_o, respectively.

The objective of the policy as set forth earlier is to induce an increase in consumption of the food product by the target group by $\lambda = \Delta q/q_o$. First, some basic expressions are derived that will be used later in computing the fiscal and unitary costs of the alternative policy options for the target group.

The increase in price needed to induce an increment in supply equal to Δq is equal to Δ_1. Denoting ε_p as the elasticity of supply faced by the target group, the following expression may be defined:

$$\varepsilon_p = [(\Delta_q/q_o)/(\Delta_1/P_o)]$$
$$+ (\Delta_1/P_o) = (\lambda/\varepsilon_p). \qquad (47)$$

If the decline in price required to induce the target group to increase consumption by λ is equal to Δ_2, then the following expression may be defined (in absolute value):

$$\eta_p = [(\Delta_q/q_o)/(\Delta_1/P_o)]$$
$$+ (\Delta_2/P_o) = (\lambda/\eta_p). \qquad (48)$$

Now the respective formulas for calculating the fiscal cost and unitary costs of a price subsidy and a food stamp program are derived.

First, if the possibility of subsidizing just the consumption of the target group is considered, then the fiscal cost of that subsidy will be

$$FC_s = (q_o + \Delta_q)(\Delta_1 + \Delta_2). \qquad (49)$$

Substituting from equations (47) and (48) and recalling that $q_o = \alpha Q_o$ and $q = \lambda\alpha Q_o$, one obtains:

$$FC_s = P_oQ_o\alpha\lambda(1 + \lambda)(1/\varepsilon_p + 1/\eta_p), \qquad (50)$$

and if $\varepsilon_p \rightarrow \infty$, then

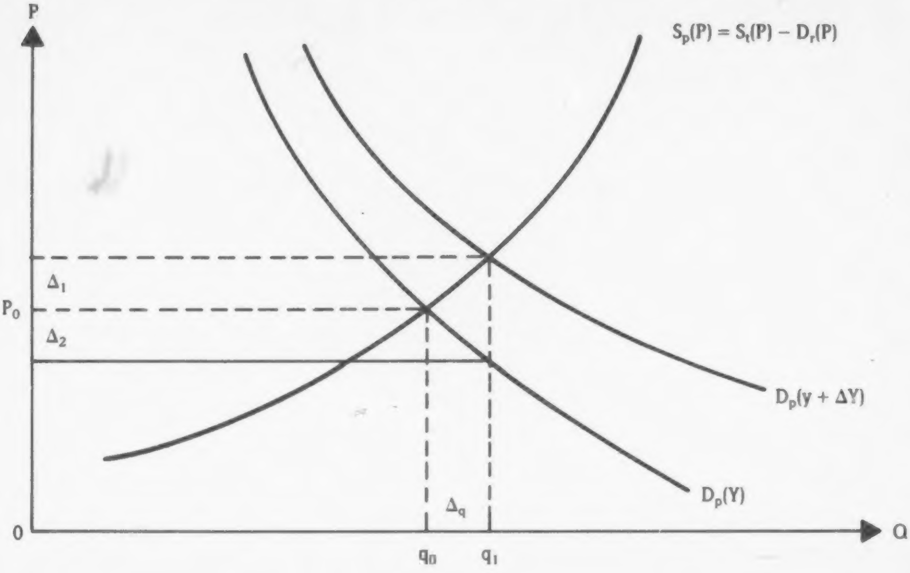
$$FC_s = P_oQ_o(\alpha\lambda/\eta_p)(1 + \lambda), \qquad (51)$$

and the unitary cost UC_s will be

$$UC_s = FC_s/\alpha\lambda Q_o. \qquad (52)$$

Next, the cost of a food stamp program is considered. The question now is, "What is the value of the income transfer or the fiscal cost FC_{FS} required to induce an increase in physical consumption of a specific product i by the target gorup in Δ_q?" Note that the value of the transfer must be able

Figure 12—Hypothetical market for a relevant product for a target group



to finance the increment Δ_q—valued at the new supply price of the product—as well as to finance the increased cost of the old consumption q_o. The transfer or fiscal cost of the program becomes

$$FC_{FS} = \Delta_1(q_o + \Delta_q) + P_o\Delta_q, \text{ and}$$

$$FC_{FS} = P_oQ_o\alpha\lambda\{[(1 + \lambda)/\varepsilon_p] + 1\}. \quad (53)$$

If $\varepsilon_p \rightarrow \infty$, then

$$FC_{FS} = P_oQ_o\alpha\lambda. \quad (54)$$

The unitary cost of the additional consumption due to the program is given by

$$UC_{FS} = FC_{FS}/\alpha\lambda Q_o. \quad (55)$$

Cost-Effectiveness of Alternative Policies

Once the disaggregative model has been applied to a comparison of the relative costs of a food stamp and a price subsidy program for a target group with a general price subsidy for food in Brazil as a whole, the cost-effectiveness of these programs can be considered. Although a search of the literature did not yield an ideal set of parameters for estimating the cost-effectiveness of the programs, those parameters that were available were used with the sensitivity analysis shown in Table 29 in order to account for possible variations. The programs, ranked in order of cost-effectiveness, were food stamp program, target-oriented price subsidy, and general price subsidy.

The difference between the cost-effectiveness of the target-oriented price subsidy and the food stamp program, for the alternative values of ε and η_p, ranged from 11 percent ($\varepsilon = 0.14$ and $\eta_p = 1.0$) to 62 percent ($\varepsilon = 0.14$ and $\eta_p = 0.7$). This means that the target-oriented price subsidy is less cost-effective than the food stamp program, but the difference was not large in comparison with the ineffectiveness of the general price subsidy (last line of Table 29). To make one dollar of food available for the target group, the cost ranged from 5.62 percent ($\varepsilon = 0.8$ and $\eta_p = 1.0$) to 27.16 percent ($\varepsilon = 0.14$ and $\eta_p = 0.7$). This means that the differences in cost-effectiveness be-

Table 29—Cost-effectiveness of target-group-oriented programs and a general food price subsidy program with different demand and supply elasticities, as a ratio of the price per unit, 1984

		Wheat Bread[a]		Rice[a]		Edible Beans[a]	
Program	**Formula**	**−1.0**	**−0.7**	**−1.0**	**−0.7**	**−1.0**	**−0.7**
Target group							
Food stamp	$1 + [(1 + \lambda)/\varepsilon_p]$	1.25	1.25	1.56	1.56	1.80	1.80
Price subsidy	$(1 + \lambda)(1/\varepsilon_p + 1/\eta_p)$	1.45	1.96	1.76	2.27	2.00	2.91
General							
Price subsidy	$1/\alpha\eta_p(1 + \eta_t/\varepsilon)$ $(1 + \lambda\eta_t/\eta_p)$	5.62	9.30	9.54	16.73	15.02	27.16

Source: Calculated by the authors.

Notes: The value of ε was obtained according to the method described in A. C. Pastore, "A Oferta de Produtos Agrícolas no Brasil," *Estudos Econômicos* 7 (No. 1, 1975): 29-64. The values of $\lambda = 0.20$, $\alpha = 0.30$, and $\eta_r = 0.2$ were assumed by the authors. In order to get η_t and η_p, the following formulas were used: $\eta_t = \eta_p + (1-\lambda)\,\eta_r$ and $\varepsilon_p = \varepsilon/\lambda + (1-\alpha)\cdot\eta_r/\alpha$.

[a] For wheat bread, the value of $\varepsilon = 0.8$ ($\varepsilon_p = 4.8$); for rice, it is $\varepsilon = 0.27$ ($\varepsilon_p = 2.15$); and for edible beans, it is $\varepsilon = 0.14$ ($\varepsilon_p = 1.50$), and for each product respectively $\eta_p = -1.0$ and -0.7.

tween the general price subsidy and the food stamp program ranged from 3.5 to 14 times.

This is a significant difference. If it were possible to shift from the present general price subsidy for wheat in Brazil to a food stamp program, it would certainly lead to a large gain in cost-effectiveness. With the same amount of financial resources, the per capita benefits for the target group (here assumed to be $\alpha = 30$ percent of the population) would be considerably larger. A shift from the general price subsidy for wheat to a food stamp program would strongly contribute to reducing the budget deficit without lowering the nutritional status of low-income people.

It is clear that this simple exercise should be improved, and more sophisticated methodologies should be used, taking into account not only the direct but also the cross-effects, to evaluate more carefully the real and monetary effects of different programs to improve the nutritional status of the low-income population in Brazil.

BIBLIOGRAPHY

Banco do Brasil. "Farm to Mill Expenses." Departamento de Comercialização do Trigo Nacional. Pôrto Alegre, Rio Grande do Sul, 1984 (mimeographed).

______. "Precos de Trigo para os Produtores e Volume de Produção." Departamento de Comercialização do Trigo Nacional. Pôrto Alegre, Rio Grande do Sul, 1983 (mimeographed).

______. "Trigo Nacional." Departamento de Comercialização do Trigo Nacional. Pôrto Alegre, Rio Grande do Sul, December 1979 (mimeographed).

Banco Central. *Brasil Programa Econômico—Ajustamento Interno e Externo.* Brasilia: Banco Central, October 1982.

Bale, Malcolm D., and Lutz, Ernst. "Price Distortions in Agriculture and Their Effects: An International Comparison." *American Journal of Agricultural Economics* 63 (February 1981): 8-22.

Barker, Randolph, and Hayami, Yujiro. "Price Support Versus Input Subsidy for Food Self-Sufficiency in Developing Countries." *American Journal of Agricultural Economics* 58 (February 1981): 617-628.

Brazil, Commission for Production Financing. "Precos e Custos Domésticos e Internacionais: Distorções, Um Estudo Preliminar." August 1983 (mimeographed).

Brazil, National Supply Superintendency, Departamento do Trigo. "Evolução do Preço do Trigo em Grão para Produtores e Moinhos e Consumo Aparente de Farinha de Trigo." Rio de Janeiro, 1983 (mimeographed).

Calegar, Geraldo M. "Brazilian Wheat Policy and Its Income Distribution and Trade Effects: A Case Study." Ph.D. dissertation, University of Minnesota, 1984.

Carvalho, Luis Eduardo. "O Caráter Social de Política de Subsídio ao Trigo." *Alimentação e Nutrição* (March 1981): 32-42.

Contador, Claudio Roberto. "Trigo Nacional: O Custo Social da Auto-Suficiência." *Estudos Econômicos* 4 (No. 3, 1974): 53-83.

Currie, J. M.; Murphy, J. A.; and Schmitz, A. "The Concept of Economic Surplus and Its Use in Economic Analysis." *Economic Journal* 81 (December 1971): 741-799.

Federação das Cooperativas Brasileiras de Trigo e Soja, LTDA. "Custo de Produção: Trigo Revisão Safra 1983, Soja-Estimativa 1983-84." Pôrto Alegre, Rio Grande Do Sul, n.d.

Ferreira e Silva, Telma. "Politica Triticola—Efeitos de uma Redução no Subsídio." M.S. thesis: Universidade Federal de Viçosa, 1981.

Fundação Getúlio Vargas. *Conjunctura Econômica* 33 (November 1977).

______. *Conjunctura Econômica* 39 (April 1985).

Fundação Instituto Brasileiro de Geografia e Estatística. *Anuário Estatístico do Brasil.* Rio de Janeiro: FIBGE, various years.

______. *Estudo Nacional da Despesa Familiar: Despesas das Famílias, Dados Preliminares.* 6 vols. Rio de Janeiro: FIBGE, 1978 and 1979.

______. *Estudo Nacional de Despesa Familiar: Tabelas de Composição de Alimentos.* 2nd edition. Rio de Janeiro: FIBGE, 1981.

______. "Special Runs of ENDEF: Consumption in Calories by Global Income Classes; Annex-A: Number of Days Researched; Annex-B: Average Number of Comensal Days." FIBGE, Rio de Janeiro, n.d. (mimeographed).

Garcia, Joâo Carlos. "Avaliação dos Impactos do Aumento na Oferta de Alimentos e Renda sobre a Nutrição Humana e suas Implicações para o Estabelecimento de Prioridades de Pesquisas Agrícolas no Brasil." Ph.D. dissertation, Universidade Federal de Viçosa, 1978.

Hall, L. L. "Evaluating the Effects of P. L. 480: Wheat Imports in Brazil's Grain Sector." *American Journal of Agricultural Economics* 62 (February 1980): 19-28.

Harberger, A. C. "Three Basic Postulates for Applied Welfare Economics: An Interpretative Essay." *Journal of Economic Literature* 9 (September, 1971): 785-797.

International Monetary Fund. *International Financial Statistics.* Washington, D.C.: IMF, 1983.

Just, R. E.; Hueth, D. L.; and Schmitz, A. *Applied Welfare Economics and Public Policy.* Englewood Cliffs, N.J.: Prentice Hall, 1982.

Kakwani, N. C. *Income Inequality and Poverty—Methods of Estimation and Policy Applications.* New York: Oxford University Press, 1980.

Knight, Peter. *Brazilian Agricultural Technology and Trade—A Study of Five Commodities.* New York: Praeger, 1971.

Lopes, Mauro R. "The Mobilization of Resources from Agriculture: A Policy Analysis of Brazil." Ph.D. dissertation, Purdue University, 1977.

Mandell, P. I. "A Expansão da Moderna Rizicultura: Crescimento de Oferta Numa Econômia Dinâmica." *Revista Brasileira de Economia* 26 (July/September 1972): 169-232.

Martin, M. V., and Brokken, R. F. "The Scarcity Syndrome: A Comment." *American Journal of Agricultural Economics* 63 (February 1983): 158-159.

McCarthy, F. D., and Taylor, Lance. "Macro Food Policy Planning: A General Equilibrium Model for Pakistan." *The Review of Economics and Statistics* 62 (February 1980): 107-121.

Mendonça de Barros, José Roberto. *Exportacões de Produtos Primários Não Tradicionais.* Série IPE-Monografias-4. São Paulo: Universidade de São Paulo, 1974.

Paniago, Euter. "An Evaluation of Agricultural Price Policies for Selected Food Products: Brazil." Ph.D. dissertation, Purdue University, 1969.

Pastore, A. C. "A Oferta de Produtos Agrícolas no Brasil." *Estudos Econômicos* 12 (No. 1, 1975): 29-64.

Pereira Soares, Ricardo. *Avaliação Econômica da Política Triticola de 1967 a 1977,* vol. 20. Brasília: Comissão de Financiamento da Produção, Coleção Análise e Pesquisa, 1980.

Portela de Lima Fernandes, D. "Aspectos Econômicos e Estatísticos do Trigo no Brasil." *Informe Agropecuário* 9 (January 1983): 1-8.

Reutlinger, Shlomo, and Selowski, Marcelo. *Malnutrition and Poverty: Magnitude and Policy Options.* Baltimore: The Johns Hopkins University Press for the World Bank, 1976.

Rojko, A.; Rieger, D.; O'Brien, A.; Coffing, A.; and Bailey, L. *Alternative Futures for World Food in 1985.* Foreign Agricultural Economics Report No. 14. Washington, D.C.: U.S. Department of Agriculture, 1978.

Scobie, Grant M. *Food Subsidies in Egypt: Their Impact on Foreign Exchange and Trade.* Research Report 40. Washington, D.C.: International Food Policy Research Institute, 1983.

Williamson Gray, Cheryl. *Food Consumption Parameters for Brazil and Their Application to Food Policy.* Research Report 32. Washington, D.C.: International Food Policy Research Institute, 1982.

World Bank. *Brazil: A Review of Agricultural Policies.* Washington, D.C.: World Bank, 1982.

______. *Brazil: Industrial Policies and Manufactured Exports.* Washington, D.C.: World Bank, 1981, Annex-2.

RECENT IFPRI RESEARCH REPORTS (continued)

47 *EVOLVING FOOD GAPS IN THE MIDDLE EAST/NORTH AFRICA: PROSPECTS AND POLICY IMPLICATIONS,* December 1984, by Nabil Khaldi

46 *THE EFFECTS ON INCOME DISTRIBUTION AND NUTRITION OF ALTERNATIVE RICE PRICE POLICIES IN THAILAND,* November 1984, by Prasarn Trairatvorakul

45 *THE EFFECTS OF THE EGYPTIAN FOOD RATION AND SUBSIDY SYSTEM ON INCOME DISTRIBUTION AND CONSUMPTION,* July 1984, by Harold Alderman and Joachim von Braun

44 *CONSTRAINTS ON KENYA'S FOOD AND BEVERAGE EXPORTS,* April 1984, by Michael Schluter

43 *CLOSING THE CEREALS GAP WITH TRADE AND FOOD AID,* January 1984, by Barbara Huddleston

42 *THE EFFECTS OF FOOD PRICE AND SUBSIDY POLICIES ON EGYPTIAN AGRICULTURE,* November 1983, by Joachim von Braun and Hartwig de Haen

41 *RURAL GROWTH LINKAGES: HOUSEHOLD EXPENDITURE PATTERNS IN MALAYSIA AND NIGERIA,* September 1983, by Peter B. R. Hazell and Ailsa Röell

40 *FOOD SUBSIDIES IN EGYPT: THEIR IMPACT ON FOREIGN EXCHANGE AND TRADE,* August 1983, by Grant M. Scobie

39 *THE WORLD RICE MARKET: STRUCTURE, CONDUCT, AND PERFORMANCE,* June 1983, by Ammar Siamwalla and Stephen Haykin

38 *POLICY MODELING OF A DUAL GRAIN MARKET: THE CASE OF WHEAT IN INDIA,* May 1983, by Raj Krishna and Ajay Chhibber

37 *SERVICE PROVISION AND RURAL DEVELOPMENT IN INDIA: A STUDY OF MIRYALGUDA TALUKA,* February 1983, by Sudhir Wanmali

36 *AGRICULTURE AND ECONOMIC GROWTH IN AN OPEN ECONOMY: THE CASE OF ARGENTINA,* December 1982, by Domingo Cavallo and Yair Mundlak

35 *POLICY OPTIONS FOR THE GRAIN ECONOMY OF THE EUROPEAN COMMUNITY: IMPLICATIONS FOR DEVELOPING COUNTRIES,* November 1982, by Ulrich Koester

34 *EGYPT'S FOOD SUBSIDY AND RATIONING SYSTEM: A DESCRIPTION,* October 1982, by Harold Alderman, Joachim von Braun, and Sakr Ahmed Sakr

33 *AGRICULTURAL GROWTH AND INDUSTRIAL PERFORMANCE IN INDIA,* October 1982, by C. Rangarajan

32 *FOOD CONSUMPTION PARAMETERS FOR BRAZIL AND THEIR APPLICATION TO FOOD POLICY,* September 1982, by Cheryl Williamson Gray

31 *SUSTAINING RAPID GROWTH IN INDIA'S FERTILIZER CONSUMPTION: A PERSPECTIVE BASED ON COMPOSITION OF USE,* August 1982, by Gunvant M. Desai

30 *INSTABILITY IN INDIAN FOODGRAIN PRODUCTION,* May 1982, by Peter B. R. Hazell

29 *GOVERNMENT POLICY AND FOOD IMPORTS: THE CASE OF WHEAT IN EGYPT,* December 1981, by Grant M. Scobie

28 *GROWTH AND EQUITY: POLICIES AND IMPLEMENTATION IN INDIAN AGRICULTURE,* November 1981, by J. S. Sarma

27 *AGRICULTURAL PRICE POLICIES UNDER COMPLEX SOCIOECONOMIC AND NATURAL CONSTRAINTS: THE CASE OF BANGLADESH,* October 1981, by Raisuddin Ahmed

26 *FOOD SECURITY IN THE SAHEL: VARIABLE IMPORT LEVY, GRAIN RESERVES, AND FOREIGN EXCHANGE ASSISTANCE,* September 1981, by John McIntire

Geraldo M. Calegar is an economist with Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA). G. Edward Schuh is dean of the Hubert H. Humphrey Institute of Public Affairs, University of Minnesota, Minneapolis.

RECENT IFPRI RESEARCH REPORTS

65 *CREDIT FOR ALLEVIATION OF RURAL POVERTY: THE GRAMEEN BANK IN BANGLADESH,* February 1988, by Mahabub Hossain

64 *COOPERATIVE DAIRY DEVELOPMENT IN KARNATAKA, INDIA: AN ASSESSMENT,* December 1987, by Harold Alderman

63 *INCOME AND NUTRITIONAL EFFECTS OF THE COMMERCIALIZATION OF AGRICULTURE IN SOUTHWESTERN KENYA,* November 1987, by Eileen T. Kennedy and Bruce Cogill

62 *AGRICULTURAL RESEARCH IN NEPAL: RESOURCE ALLOCATION, STRUCTURE, AND INCENTIVES,* September 1987, by Ram P. Yadav

61 *THE PILOT FOOD PRICE SUBSIDY SCHEME IN THE PHILIPPINES: ITS IMPACT ON INCOME, FOOD CONSUMPTION, AND NUTRITIONAL STATUS,* August 1987, by Marito Garcia and Per Pinstrup-Andersen

60 *POPULATION POLICY AND INDIVIDUAL CHOICE: A THEORETICAL INVESTIGATION,* June 1987, by Marc Nerlove, Assaf Razin, and Efraim Sadka

59 *PRODUCTION INCENTIVES IN PHILIPPINE AGRICULTURE: EFFECTS OF TRADE AND EXCHANGE RATE POLICIES,* May 1987, by Romeo M. Bautista

58 *THE FOOD STAMP SCHEME IN SRI LANKA: COSTS, BENEFITS, AND OPTIONS FOR MODIFICATION,* March 1987, by Neville Edirisinghe

57 *CEREAL FEED USE IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 2000,* December 1986, by J. S. Sarma

56 *THE EFFECTS OF TRADE AND EXCHANGE RATE POLICIES ON AGRICULTURE IN ZAIRE,* November 1986, by Tshikala B. Tshibaka

55 *THE EFFECTS OF TRADE AND EXCHANGE RATE POLICIES ON AGRICULTURE IN NIGERIA,* October 1986, by T. Ademola Oyejide

54 *WEATHER AND GRAIN YIELDS IN THE SOVIET UNION,* September 1986, by Padma Desai

53 *REGIONAL COOPERATION TO IMPROVE FOOD SECURITY IN SOUTHERN AND EASTERN AFRICAN COUNTRIES,* July 1986, by Ulrich Koester

52 *FOOD IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 2000,* June 1986, by Leonardo A. Paulino

51 *DETERMINANTS OF AGRICULTURAL POLICIES IN THE UNITED STATES AND THE EUROPEAN COMMUNITY,* November 1985, by Michel Petit

50 *GOVERNMENT EXPENDITURES ON AGRICULTURE AND AGRICULTURAL GROWTH IN LATIN AMERICA,* October 1985, by Victor J. Elías

49 *LIVESTOCK PRODUCTS IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 1990 AND 2000,* April 1985, by J. S. Sarma and Patrick Yeung

48 *RURAL HOUSEHOLD USE OF SERVICES: A STUDY OF MIRYALGUDA TALUKA, INDIA,* March 1985, by Sudhir Wanmali

(continued on inside back cover)

International Food Policy Research Institute
1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 USA

RESEARCH REPORT

67

[illegible]

NATURE AND IMPACT OF THE GREEN REVOLUTION IN BANGLADESH

Mahabub Hossain

July 1988

INTERNATIONAL
FOOD
POLICY
RESEARCH
INSTITUTE

In collaboration with the
BANGLADESH
INSTITUTE OF
DEVELOPMENT
STUDIES

The **International Food Policy Research Institute** was established in 1975 to identify and analyze alternative national and international strategies and policies for meeting food needs in the world, with particular emphasis on low-income countries and on the poorer groups in those countries. While the research effort is geared to the precise objective of contributing to the reduction of hunger and malnutrition, the factors involved are many and wide-ranging, requiring analysis of underlying processes and extending beyond a narrowly defined food sector. The Institute's research program reflects worldwide interaction with policymakers, administrators, and others concerned with increasing food production and with improving the equity of its distribution. Research results are published and distributed to officials and others concerned with national and international food and agricultural policy.

The Institute receives support as a constituent of the Consultative Group on International Agricultural Research from a number of donors including Australia, Belgium, Canada, the People's Republic of China, the Ford Foundation, France, the Federal Republic of Germany, India, Italy, Japan, the Netherlands, Norway, the Philippines, the Rockefeller Foundation, Switzerland, the United Kingdom, the United States, and the World Bank. In addition, a number of other governments and institutions contribute funding to special research projects.

Board of Trustees

Dick de Zeeuw
Chairman, Netherlands

Eliseu Roberto de Andrade Alves
Vice Chairman, Brazil

Yahia Bakour
Syria

Anna Ferro-Luzzi
Italy

Yujiro Hayami
Japan

Gerald Karl Helleiner
Canada

Dharma Kumar
India

Anne de Lattre
France

James R. McWilliam
Australia

Harris Mutio Mule
Kenya

Sukadji Ranuwihardjo
Indonesia

Theodore W. Schultz
U.S.A.

Leopoldo Solís
Mexico

M. Syeduzzaman
Bangladesh

Charles Valy Tuho
Côte d'Ivoire

John W. Mellor, Director
Ex Officio, U.S.A.

NATURE AND IMPACT OF THE GREEN REVOLUTION IN BANGLADESH

Mahabub Hossain

Research Report 67
International Food Policy Research Institute
in collaboration with the
Bangladesh Institute of Development Studies
July 1988

Copyright 1988 International Food Policy
Research Institute.

All rights reserved. Sections of this report may be reproduced without the express permission of but with acknowledgment to the International Food Policy Research Institute.

Library of Congress Cataloging
in Publication Data

Hossain, Mahabub, 1945-
Nature and impact of the green revolution in Bangladesh.

(Research report ; no. 67)
Bibliography: p. 139.
1. Agriculture—Economic aspects—Bangladesh. 2. Agricultural innovations—Economic aspects—Bangladesh. 3. Green Revolution—Bangladesh. I. Title. II. Series: Research report (International Food Policy Research Institute); no. 67.

HD2075.6.H67 1988 338.1'09549'2 88-13325
ISBN 0-89629-070-0

CONTENTS

Foreword

1. Summary 11
2. Introduction 14
3. Technological Progress and Growth of Crop Production—A Macro Picture 21
4. Nature of Alternative Rice Technologies 40
5. Productivity and Efficiency of Resource Use 58
6. Farm Size, Tenancy, and Adoption of Modern Technology 71
7. Labor Market and Employment Effects of Modern Technology 89
8. Linkage Effects of Agricultural Growth 108
9. Effect on Income Distribution and Poverty 119
10. Policy Implications 131

Appendix: Supplementary Tables 137

Bibliography 139

TABLES

1. Basic characteristics of villages under study, 1982 18
2. Distribution pattern of landownership in sample, 1982 19
3. Changes in pattern of land use, 1950-85 21
4. Changes in intensity of land use, 1950-85 23
5. Changes in distribution pattern of landholdings, 1960-83/84 23
6. Expansion of area under modern-variety (MV) seeds, 1967-86 25
7. Development of modern irrigation facilities, 1960-85 27
8. Trends in consumption of chemical fertilizers, by season, 1960-85 30
9. Association of fertilizer consumption and adoption of modern varieties (MVs) with irrigation, 1983/84 32
10. Growth in crop production before and after introduction of modern technology 36
11. Changes in food and nonfood consumer prices before and after introduction of modern technology 37
12. Estimates of crop yield for traditional and modern varieties of rice 42
13. Variation in yield for traditional and modern varieties of rice, 1981 and 1982 43
14. Farmers' perception of extent of crop damage, 1982 43
15. Labor input in rice cultivation for traditional and modern varieties, 1980-82 averages 44
16. Use of hired labor under traditional and modern varieties of rice, 1982 45
17. Use of animal and mechanical power for traditional and modern varieties, 1979/80-1981/82 averages 46
18. Use of chemical fertilizers and manure for traditional and modern varieties, 1980-82 averages 48
19. Use of irrigation and pesticides under traditional and modern varieties of rice, 1980-82 averages 49
20. Cost of seeds for traditional and modern varieties of rice, 1982 50
21. Costs of production and profits under traditional and modern varieties, at 1984/85 national-level prices 53
22. Effect of price changes on costs of production and profits, 1975/76-1984/85 54
23. Costs and profitability at farm-specific prices, production and input use, 1982 56
24. Profits and family income at farm-specific prices for different farm sizes and tenurial groups, 1982 56
25. Pattern and intensity of use of irrigated and unirrigated land, 1981 59
26. Pattern and intensity of land use in technologically developed and underdeveloped villages, 1981 60

27. Estimates of Cobb-Douglas production functions for different varieties of rice, 1982 62

28. Estimates of average and marginal products of land and labor, crop level, 1982 63

29. Selected characteristics of profitable and unprofitable sample farms, 1982 66

30. Tests of hypothesis of relative and absolute price efficiency and constant returns to scale 67

31. Joint estimates of profit functions and input demand equations, 1982 68

32. Adoption of modern varieties of rice, by farm size and tenancy, 1982 74

33. Incidence of tenancy, by season and technology, 1982 75

34. Adoption of modern varieties on owned and rented land for mixed-tenant farmers, by season, 1982 76

35. Adoption of modern varieties, by land elevation and access to irrigation facilities, 1981 77

36. Adoption of modern varieties in irrigated and unirrigated villages, by farm size, 1982 77

37. Adoption of modern varieties by type of irrigation and length of experience, 1982 78

38. Use of chemical fertilizers, by farm size and tenancy, 1982 79

39. Factors influencing decision to adopt modern varieties, probit estimate 81

40. Determinants of adoption of modern varieties of rice, 1982 83

41. Incidence of irrigation and tenancy for different groups of farmers 85

42. Farm size and land productivity, by technology, 1982 87

43. Prices of major agricultural inputs, by farm size and tenancy, 1982 87

44. Labor force participation in developed and underdeveloped areas, by landholding, 1982 90

45. Occupation of family members aged 10 to 25, by landownership and sex, 1982 92

46. Duration of employment in technologically developed and underdeveloped areas, by landownership group, 1982 94

47. Duration of employment in agricultural and nonagricultural activities, by technology and landownership group, 1982 94

48. Labor supply in different activities in developed and underdeveloped areas, for all rural households, 1982 95

49. Size of labor market from the supply side, by sector, 1982 96

50. Nature and size of agricultural labor market from the demand side, by landownership group, 1982 97

51. Participation in labor market for different landownership groups, 1982 98

52. Wage rate received for hired labor, by technology, landholding, and sex of workers, 1982 98

53. Wage rate paid by sample farmers for agricultural labor in technologically developed and underdeveloped villages, 1982 100

54. Estimates of labor supply functions for all rural households, 1982 102

55. Estimates of labor supply functions for landless and marginal landowning households, 1982 104

56. Use of labor in crop production in developed and underdeveloped villages, by amount of land owned, 1982 105

57. Estimates of Engel function for rural households, 1982 110

58. Estimates of marginal budget shares and expenditure elasticity of demand, 1982 111

59. Expenditure pattern of households in developed and underdeveloped villages, 1982 112

60. Pattern of investment in technologically developed and underdeveloped villages, 1982 114

61. Pattern of investment for different landownership groups, 1982 115

62. Sources of landholdings in technologically developed and underdeveloped villages, from inheritance to 1982 116

63. Transactions in the land market in technologically developed and underdeveloped villages, 1982 117

64. Structure of household incomes in technologically developed and underdeveloped villages, 1982 120

65. Estimates of household income in developed and underdeveloped villages, 1982 121

66. Incomes earned through the labor market, by technology and landholding groups, 1982 122

67. Determinants of rural household incomes: regression estimates, 1982 124

68. Distribution of household income in technologically developed and underdeveloped villages, 1982 126

69. Degree of inequality in distribution of income and landholding: Gini ratios for sample households, 1982 128

70. Estimates of incidence of poverty in technologically developed and underdeveloped villages, 1982 129

71. Incidence of poverty, by landownership group and technology, 1982 130

72. Estimates of growth equations for crop production, 1950-85 137

73. Marginal budget shares and expenditure elasticity of demand for different commodities, 1982 138

ILLUSTRATIONS

1. Trends in cultivated area and cropped area, 1950-85 22
2. Expansion in modern irrigation and modern-variety seeds, 1960-84 31
3. Trend in fertilizer use, 1960-84 31
4. Trends in yield of cereal and non-cereal crops, 1950-85 35
5. Lorenz curve showing the pattern of distribution of income in developed and underdeveloped villages along per capita income scale, 1982 127

FOREWORD

The International Food Policy Research Institute has always emphasized the role of modern technology in increasing the food supply of low-income countries. The growth in productivity that results from technology diffusion generates linkage effects that can lead to all-around economic development. IFPRI is profoundly concerned about the policies needed to encourage and increase the effectiveness of technology adoption and to maximize agricultural growth linkage effects in achieving major social objectives such as alleviation of poverty. It is clear that for poor, land-scarce countries like Bangladesh, food supplies necessary to meet even minimum expected growth rates of population and per capita income during the next few decades cannot be realized without development of higher-yielding cereal varieties and their accelerated spread to farmers' fields. Failure to increase food supplies at a matching rate will increase food prices and accentuate poverty, since the poor spend a large proportion of their income on food.

This report by Mahabub Hossain, a staff member of the Bangladesh Institute of Development Studies (BIDS), Dhaka, is an outcome of IFPRI's continuing research efforts on the above issue. The report assesses the pace of diffusion of the seed-fertilizer-water technology in Bangladesh and the impact of this technology on the growth of production. It examines input use, productivity, and profitability of modern varieties of rice compared with traditional varieties. It evaluates the impact of technological progress on income distribution and alleviation of poverty by looking at the pattern of technology adoption among different groups of farmers and at the generation of employment for the landless in agriculture and in rural nonfarm activities through linkage effects of agricultural growth. The report concludes that in Bangladesh the new technology has opened up great opportunities to increase food production and farm income and that it has a fairly neutral income-distribution effect. The incidence of poverty is found to be substantially lower in technologically developed villages than in underdeveloped ones.

A major finding of this study is that the poor gain from the new technology through the operation of the labor market. As agricultural incomes and labor productivity increase, farm households substitute leisure for labor and supply less labor in the market. This redistributes agricultural employment from higher- to lower-income groups. Such redistribution, together with an increase in the demand for labor owing to the higher labor intensity of the modern rice varieties, puts an upward pressure on the wage rate and increases wage earnings from the same amount of labor. Some income adjustments may also take place between technologically developed and underdeveloped villages through operation of rural-rural migration of agricultural workers.

This study is one of a series of collaborative research efforts between IFPRI and BIDS since 1981. The fieldwork was carried out by BIDS in connection with a joint IFPRI/BIDS evaluation of the food-for-work program in Bangladesh, the final report of which was submitted in 1985. IFPRI is pleased to have provided support to the author in Washington, D.C., for analyzing the data and writing the present report. The study was partially funded by the Ford Foundation office in Dhaka, Bangladesh. IFPRI is grateful to the foundation for its encouragement and support of this work.

John W. Mellor

Washington, D.C.
July 1988

ACKNOWLEDGMENTS

The author is especially indebted to John W. Mellor and Rehman Sobhan for their encouragement and counsel at every stage of this research and to Raisuddin Ahmed for valuable interactions and discussions. Joachim von Braun, Robert W. Herdt, John C. Flinn, Keijiro Otsuka, Steve Jones, and Noel P. Magor read an earlier draft of this report, and the present version has benefited greatly from their comments. The author is grateful to them, although he alone remains responsible for the remaining errors and inadequacies. The author is also grateful to Andrew Bernard for his competent research assistance and active interest in the study.

1

SUMMARY

A major constraint to increasing food production in Bangladesh is the limited supply of land. There is little scope for expanding cultivable land beyond the 22 million acres from which the country now feeds more than 100 million people. The cultivated land area has remained unchanged since independence in 1971, although the population has increased by about 50 percent since then. The growth of cereal production since the early 1970s has barely managed to keep food imports at 10 percent of domestic demand despite a respectable progress in the diffusion of new agricultural technology, modern seed varieties of rice and wheat, and chemical fertilizers.

Technological progress is the key to maintaining the national food-population balance—and the scope for further diffusion of the new technology is vast. Only about a third of the rice and wheat area has been covered with modern-variety seeds, and the consumption of chemical fertilizers has reached 18 nutrient kilograms per acre. But because of the results of early studies on the "green revolution" in India, there is widespread apprehension in Bangladesh that diffusion of the new technology may contribute to worsening income inequality and deepening absolute poverty.

There have been few systematic and representative studies on Bangladesh that examined the effects of technological change at the farm and economy levels. In 1979-82 a survey was made of 2,400 sample farms in 117 villages throughout the country; a second large survey of 16 villages was completed in 1981-82. This study analyzes these two sets of survey data to assess the effects of modern rice technology on productivity and equity.

The yield of paddy is estimated at 1.34 metric tons per acre for modern varieties, compared with 0.65 ton for local varieties, and the estimated profit is Tk 2,300 and Tk 1,050, respectively. In Bangladesh, where land is so scarce and the size of landholdings so small, high profit per acre is important, but cost per ton of output is a more conclusive measure of profitability. The cost per ton of paddy output was Tk 3,700 for local varieties and Tk 3,000 for the new varieties, clearly demonstrating that the value of increased output exceeded the increased costs of growing the modern varieties. At 1984/85 prices the net return to family labor was Tk 87 per day for modern varieties and Tk 75 for local varieties, compared with the agricultural wage rate of Tk 24 per day.

Small farmers and tenants adopted the new technology as readily as did medium and large ones. Farmers operating less than 2.5 acres of land allocated 52 percent of their rice land to modern varieties, compared with 45 percent for those with 2.5-5.0 acres and 42 percent for those with 5.0 acres of land or more. The yield per acre was also higher on smaller farms. But profits and family income were lower on smaller farms because they paid about 25 percent higher water charges and about 10 percent higher wage rates than the large farms. The profits were substantially less on rented land, since the tenant has to pay 50 percent of the gross produce as rent and bear all costs of inputs. But the profits per acre on tenant farms were higher for the modern varieties than for local varieties. Diffusion of the new technology thus increases income for all groups of farmers, but also increases the inequality in the distribution of agricultural income among farm households.

To get an overall indication of the effect of new technology on income distribution, the survey villages were divided into two equal groups according to the degree to which the new technology was used. In the technologically developed villages, 54 percent of the land was irrigated and farmers allocated 61 percent to modern rice varieties, compared with 8 and 5 percent, respectively, for the underdeveloped villages. The difference in fertilizer use was eight times between the two groups of villages. In the developed villages, total household income was 29 percent higher and per capita income 22 percent higher than in the underdeveloped villages. However, the comparative patterns of income distribution for all rural households (including the landless) show a neutral effect for the new technology. The Gini concentration ratio of household income was the same (0.39) in the two groups of villages, but the concentration ratio measured along the per capita income scale was slightly higher in the developed villages (0.36) than in the underdeveloped ones (0.34). The comparison of income for the two groups of villages in the per capita income scale shows that the relative position of the bottom 40 percent of the households remained unchanged, while the top 20 percent gained relatively at the expense of the middle 40 percent. The proportion of population living below the poverty line was 32 percent in the developed villages and 47 percent in the underdeveloped villages.

The positive effect of the new technology on alleviation of poverty resulted from substantial increases in the income of the functionally landless households (which have less than 0.5 acre of land and are the bottom one-third of households in the landholding scale) through higher employment and wages. The annual income for this group of households was about Tk 14,300 in the developed villages compared with Tk 9,700 in the underdeveloped villages—the difference in income for the landless between the two groups of villages was almost equal to that for the large landowners (with 5.0 acres of land or more). The farmers used 45 percent additional labor in growing modern varieties. Irrigation, by increasing cropping by about one-third, also increased the demand for labor. But as income increases, higher-income households substitute leisure for labor and supply less labor in the market. The increased labor demand is met by more employment for the functionally landless in developed villages and for lower-income households in underdeveloped villages. Total employment was 4 percent higher in the developed villages; for the functionally landless group it was 26 percent higher. The new technology also puts a significant upward pressure on the wage rate, which is another factor behind increases in the income of the poor. The wage rate for agricultural labor was about 25 percent higher in the developed villages than in the underdeveloped ones.

The growth of income from the new technology expands the market for nonfarm goods and services. In the underdeveloped villages, households spent about 60 percent of the marginal budget on the output of the crop and forestry sectors, which are land-based; in the developed villages, the share was 47 percent. The marginal budget share of rural services, which are mostly labor-based, and in which the poor are more involved, was about 18 percent in developed villages and 7.5 percent in underdeveloped villages. The expenditure pattern thus appears to be another mechanism through which some benefits of the new technology trickle down to lower-income groups.

The increased income, however, does not promote capital accumulation in agriculture or in nonfarm activities. The rate of directly productive investment is estimated at 7.3 percent of total expenditure in the developed villages, compared with 11.7 percent in the underdeveloped villages. The high-income group spends proportionately more for improvement of housing and for transfers, such as purchases of land. Households in developed villages acquired about 32 percent of the land through the market, compared with 25 percent for underdeveloped villages. The impact of the new technology on the land market may cause further concentration of landholding and greater inequality in the distribution of agricultural income.

Thus there is a case for siphoning off from the upper income groups some of the surplus accumulated through technological diffusion. This may be achieved through higher agricultural taxation and the cost recovery of public investment in agriculture. It may be advisable to withdraw subsidies on sales of irrigation equipment to individuals, since such sales mostly benefit the large and medium landowners. A reallocation of public investment from major irrigation projects to small-scale projects with pumps and tubewells—to the extent it is technically feasible—may also save resources, because the cost recovery from large-scale projects has proved to be extremely difficult. The government will need additional resources from domestic sources for irrigation investment and for strengthening agricultural research, extension, and credit institutions to promote further diffusion of the new technology. The present low levels of cereal prices in international markets and political pressures from cereal-surplus developed countries suggest that it may be increasingly difficult for the government to mobilize foreign aid for this purpose.

2

INTRODUCTION

There are few countries in the Third World where technological progress is of higher importance in maintaining the food-population balance than in Bangladesh. The country now supports a population of more than 100 million people with a density of 700 per square kilometer. The growth rate of population, which has started declining only recently, is still about 2.3 percent a year. Since per capita income is extremely low, nearly two-thirds of the income is spent on food. The income elasticity of demand for food (mostly rice) is variously estimated at 0.53-0.73.[1] Thus, if the country is to maintain a modest per capita income growth of about 2 percent a year, which has been the case since it gained independence from Pakistan in 1971, food production has to grow at over 3.4 percent a year to avoid a further increase in cereal imports, which are currently about 10 percent of domestic demand.

But agriculture does not have the resources to meet that challenge. Practically all cultivable land is in use, and the pressure of increasing population reduced the average size of a farm holding from 3.53 acres in 1960 to 2.25 acres in 1983/84.[2] The increase in intensity of land use through raising additional crops during a year (cropping intensity), which was the major source of growth of crop production until the late 1960s, has slowed down considerably in recent years. Nearly 85 percent of the cropped land is devoted to production of cereals, indicating that there is little scope for diversion of land from nonfood to food crops. Since Bangladesh was densely populated decades earlier (200 persons per square kilometer in 1901), the possibility of increasing production through additional use of labor in individual crop varieties may also have been exhausted long ago.

Thus, rapid technological progress is the key to maintaining the food-population balance in the country. This was recognized by the government in the early 1960s. At that time farmers rarely used modern agricultural inputs such as chemical fertilizers and irrigation. Fertilizer application was limited to tea gardens and government experimental farms, and irrigation was practiced on about 7 percent of the land, using labor-intensive indigenous methods. The major constraints to application of modern agricultural inputs were the flooding of land during the rainy season and the lack of irrigation facilities during the dry season. Recognizing that farmers would not come forward to make indivisible investments in modern irrigation equipment because of the small farm size and the scattered and fragmented nature of holdings, the government set up the Bangladesh Water Development Board (BWDB), with responsibility for developing the water resources of the country through multipurpose flood control, drainage, and irrigation projects. At the same time, the Bangladesh Agricultural Development Corporation (BADC) was established to procure modern irrigation equipment, chemical fertilizers, and improved seeds and distribute them among farmers at highly subsidized prices.

---

[1] For various estimates of the income and expenditure elasticity of the demand for food for Bangladesh, see Wahiduddin Mahmud, "Foodgrain Demand Elasticities of Rural Households in Bangladesh: An Analysis of Pooled Cross-Section Data," *The Bangladesh Development Studies* 7 (No. 1, 1979): 59-70; Bangladesh, Bureau of Statistics, *Report of the Bangladesh Household Expenditure Survey, 1981-82* (Dhaka: Ministry of Planning, 1986), pp. 34-39; and Raisuddin Ahmed, *Agricultural Price Policies under Complex Socioeconomic and Natural Constraints,* Research Report 27 (Washington, D.C.: International Food Policy Research Institute, 1981), pp. 52-56.

[2] Bangladesh, Bureau of Statistics, *The Bangladesh Census of Agriculture and Livestock: 1983-84,* vol. 1 (Dhaka: Ministry of Planning, 1986), pp.32-33.

Thanks to the efforts of these institutions, Bangladesh has experienced some progress in the use of modern agricultural inputs over the last 25 years. The modern varieties (MVs) of rice seeds developed in international research stations were made available to farmers for dry season (boro) crops in 1968 and wet season (aman) crops in 1970, but their diffusion really picked up after the mid-1970s. By 1984/85 the area irrigated by modern methods had increased to about one-fifth of cultivated land. Irrigation, along with flood control and improved drainage, facilitated the spread of modern-input-responsive MVs, which now cover about one-fourth of cropped land and one-third of sown area under cereal crops. The expansion of irrigation and the shift of cropped land from traditional varieties to MVs have been the major factors behind the rapid growth in fertilizer consumption, which rose from insignificance in the early 1960s to about 18 kilograms of nutrients per acre of cropped land in 1984/85 despite the gradual withdrawal of a subsidy on this input since the mid-1970s.[3] The above figures also indicate that the potential for further increase in production through diffusion of modern technology is still vast. It largely depends on the capacity of the government to accelerate investment in irrigation, flood control, and drainage, which determines the expansion of the other two elements of modern technology—MV seeds and chemical fertilizers.

In Bangladesh, however, modern technology is widely believed to be contributing to worsening income inequality and deepening absolute poverty.[4] This view is prevalent among development thinkers and practitioners in the country as well as within the donor community that finances most of the investment in water resource development. The growth in crop production in the postindependence period has been faster than it was during the previous two decades (1950-71),[5] but studies based on household expenditure surveys show that absolute poverty afflicts two-thirds to four-fifths of the rural population and that it worsened alarmingly during the 1970s.[6] Other indirect evidences of the deteriorating economic condition of the rural poor in the 1970s are downward trends in the real wages of agricultural laborers and in the intake of energy and protein. The results of the national nutrition surveys show that the per capita daily energy intake declined by about 9 percent between 1962-64 and 1975/76, and another 7 percent by 1981/82.[7]

In view of the above observations, concerns are expressed about the role of modern technology in improving the condition of the poor. The hypothesis is that the effect of production growth from application of modern technology is felt much more on the increase in land and labor productivity, which is appropriated mainly by the higher-income groups, than on the generation of new employment or on the increase in wage rate from which the poor may gain. This impression is obtained from early studies on the "green revolution" in India. These studies argued that, although the new agricultural technology is scale neutral, small farmers cannot participate in its diffusion as much as large ones because the new crop varieties require a large amount of investment in purchased inputs that the poor cannot afford, and small farmers have little access to financial institutions from which working capital can be borrowed on reasonable terms. Also, by making agricultural enterprises more profitable for larger farmers, the new technology forces tenants off the land as tenancy evictions follow, and the new inflated surplus of the rich is used to buy out the marginal and small landholders, forcing them into landlessness. The net result, it is argued, is a rapid increase in the inequality of income and asset distribution and a worsening of rural poverty.[8]

---

[3] For details of developments in the field of fertilizer consumption, see Bruce Stone, ed., *Fertilizer Pricing Policy in Bangladesh* (Washington, D.C.: International Food Policy Research Institute/Bangladesh Institute of Development Studies, 1987).

[4] See, for example, Mosharraf Hossain, A. Rashid, and Selim Jahan, *Rural Poverty in Bangladesh: A Report to the Like-minded Group* (Dhaka: Dhaka University Press, 1986); Willem van Schendel, *Peasant Mobility: The Odds of Peasant Life in Bangladesh* (Assen, the Netherlands: Van Gorcum, 1981).

[5] Mahabub Hossain, "Agricultural Development in Bangladesh: A Historical Perspective," *The Bangladesh Development Studies* 12 (December 1984): 29-57.

[6] Azizur R. Khan, "Poverty and Inequality in Rural Bangladesh," in *Poverty and Landlessness in Rural Asia,* ed. Keith Griffin and Azizur R. Khan (Geneva: International Labour Organisation, 1977); Quazi K. Ahmad and Mahabub Hossain, "An Evaluation of Selected Policies and Programs for Alleviation of Rural Poverty in Bangladesh," in *Strategies for Alleviating Poverty in Rural Asia,* ed. Rizwanul Islam (Bangkok: International Labour Organisation, Asian Employment Programme, 1985), pp. 67-98.

[7] Nazmul Hasan and Kamaluddin Ahmad, "Studies on Food and Nutrient Intake by Rural Population of Bangladesh," *Ecology of Food and Nutrition* 15 (No. 12, 1984): 143-158.

A contrasting view, which has only recently been appreciated, is that the new technology may benefit the poor in the long run by (1) reducing the cost of production and thereby lowering the prices of food, and (2) generating more employment in nonfarm sectors by keeping real wages low and stimulating demand for nonfarm goods and services.[9] Since most of the income of the poor originates from labor, and their marginal propensity to consume food is very high, these indirect effects of technological progress are considered highly favorable. According to this view, if poverty increases it is because of technological progress too late and slow for its favorable effects to outweigh the unfavorable effects of high population growth,[10] and delays in adopting new technology will result in even more accentuation of poverty.

The above hypotheses regarding the nature and impact of the new agricultural technology have not yet been rigorously tested for Bangladesh. A large number of village studies have been undertaken to look into the effects of farm size and tenancy on productivity, and these studies provide information on adoption of MVs and use of fertilizer for different groups of farms.[11] But the studies are not based on a rigorous and systematic treatment of sufficiently large and disaggregated data, so the results are speculative and conjectural in nature and do not show any consistent pattern. The few rigorous attempts that have been made are based on data collected from one or two villages during the early 1970s when the technology had not progressed very far. The effect of the technology on employment and its indirect effects on nonfarm activity and on income distribution among rural households are also poorly documented. An in-depth investigation into the characteristics of the new technology and its effects on productivity and income distribution is overdue. This is the objective of this study.

Two large household surveys conducted in recent years provide disaggregated information that forms the basis of this study. The first of these was conducted by the

---

[8] For a detailed articulation of this view, see Keith Griffin, *The Political Economy of Agrarian Change: An Essay on the Green Revolution* (Cambridge: Harvard University Press, 1974); and Andrew Pears, *Seeds of Plenty, Seeds of Want: Social and Economic Implications of the Green Revolution* (Oxford: Clarendon Press, 1980). For a detailed empirical study reporting the early results of the new agricultural technology in India, see B. H. Farmer, ed., *Green Revolution? Technology and Change in Rice-Growing Areas of Tamil Nadu and Sri Lanka* (London: Macmillan, 1977).

[9] For this view, see John W. Mellor, "Determinants of Rural Poverty: The Dynamics of Production, Technology, and Price," in *Agricultural Change and Rural Poverty,* ed. John W. Mellor and Gunvant M. Desai (Baltimore and London: Johns Hopkins University Press, 1985, pp. 21-40); and John W. Mellor, "Food Price Policy and Income Distribution in Low-Income Countries," *Economic Development and Cultural Change* 27 (October 1978): 1-26.

[10] This is supported by M. L. Dantwala, "Technology, Growth, and Equity in Agriculture," in Mellor and Desai, *Agricultural Change and Rural Poverty,* pp. 110-123.

[11] A survey of the results of these studies can be obtained from Robert W. Herdt and L. Garcia, "Adoption of Modern Rice Technology: The Impact of Size and Tenure in Bangladesh," International Rice Research Institute, Manila, 1982 (mimeographed).

International Fertilizer Development Center (IFDC) in collaboration with the Bangladesh Agricultural Research Council to study the distributional consequences of fertilizer use. This is the most comprehensive farm survey conducted so far in the country. The survey work started with the 1979 aman season crops and continued for 10 consecutive seasons up to the 1982 aman season crops. A multistage, random sampling method was used in the survey, which ultimately covered 2,400 sample farms and about 10,000 sample plots in 117 villages from 20 upazilas scattered throughout 16 of the 21 Bangladesh (old) districts. Detailed input-output data were collected at the plot level for all crops, disaggregated by the type of technology used. The unpublished plot- or farm-level data were not available, but detailed disaggregated information was presented at the crop and technology levels in the published reports of the survey,[12] which has been used here for analyzing the nature of modern varieties of rice vis-à-vis traditional ones.

The second survey was conducted by the International Food Policy Research Institute in collaboration with the Bangladesh Institute of Development Studies to evaluate the development effects of the infrastructure created under the food-for-work program in the country.[13] The survey was conducted in 16 selected villages scattered through the four administrative divisions of the country and represents the principal ecological zones. A census of all households in the selected villages was carried out to serve as the sample frame for the study. The households were classified into eight groups based on the size of the landholding (four groups) and the occupation of the head of household (agriculture or nonagriculture). A proportionate random sample was then drawn from each stratum so as to have 40 households in each village. The total sample size thus consists of 640 households and about 5,200 plots operated by them. A few sample households could not be included in the analysis because of missing observations and doubtful information. The author was involved in the design and implementation of the survey.

The fieldwork was conducted from September 1981 to January 1983, administering five sets of structural questionnaires to collect information on the pattern of land use at the plot level in calendar year 1981, costs and returns for various crops grown at the farm level during 1982, and employment, income, investment, and consumption at the household level for 1982. The disaggregated household and plot data have been analyzed here to investigate the effects of the modern technology on productivity, employment, and income.

The villages studied represent a wide range of development of modern rice technology (see Table 1). In five villages, less than 5 percent of the cropped area was covered by modern varieties of rice, while in four others more than 70 percent of the area was covered by MVs. The variation is mainly the result of access to irrigation facilities, which have been developed primarily by the government during the last two decades and mostly through foreign assistance. Such facilities were almost nonexistent in four of the villages, two of them located in the coastal district of Khulna, where salinity of the water makes irrigation development difficult. In three other districts, some of the area was irrigated by indigenous methods (swing baskets and wooden lifters called *dhones*). At the other end, there were irrigation facilities for more than 50 percent of the cultivated land in five villages, three of them located in Comilla, where irrigation

---

[12] International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1979/80* and *1981/82* (Muscle Shoals, Ala.: IFDC, 1982, 1984).

[13] Bangladesh Institute of Development Studies/International Food Policy Research Institute, *Development Impact of the Food-for-Work Program in Bangladesh,* a report submitted to the World Food Programme (Washington, D.C.: International Food Policy Research Institute, 1985).

Table 1—Basic characteristics of villages under study, 1982

Village	District	Average Size of Land-holding	Average Household Size	Share of Land Irrigated	Share of Cropped Land Under Modern Varieties of Rice	Fertilizer Consumption per Acre of Cropped Land[a]	Share of Crop Area Under Tenancy
		(acres)	(persons)	(percent)	(percent)	(kilograms)	(percent)
Developed area		2.26	6.52	53.8	61.4	82.2	16.0
Chasapara	Comilla	2.14	6.80	86.9	99.5	126.4	16.4
Illashpur	Comilla	1.67	6.78	56.3	73.2	133.6	21.1
Khunta	Comilla	1.80	6.23	83.3	83.2	130.4	15.8
Harishpur	Jessore	3.72	6.88	52.9	81.0	94.3	27.1
Rawtora	Pabna	0.98	6.89	58.0	46.9	65.1	2.5
Rajarampur	Dhaka	2.61	5.40	32.9	33.9	22.2	17.1
Charkhamar	Dhaka	2.50	6.40	42.4	25.7	30.3	4.7
Bandabeel	Kushtia	2.65	6.79	36.3	24.7	32.4	13.5
Underdeveloped area		2.26	6.35	8.0	5.2	10.8	15.9
Govindapur	Dhaka	2.36	5.43	20.4	13.8	14.1	7.8
Sayedpur	Dhaka	2.03	6.30	8.8	3.2	6.9	12.9
Patgari	Pabna	1.77	6.68	12.6	10.4	13.1	5.0
Roakuli	Kushtia	3.41	6.63	3.8	4.0	18.1	3.6
Gobrapara	Jessore	3.62	7.53	3.9	0.0	7.9	19.5
Khejurdanga	Khulna	1.61	5.62	13.8	17.2	30.1	14.8
Birhat	Khulna	1.84	6.25	0.0	0.0	1.0	36.2
Taliamara	Khulna	1.45	5.05	0.0	0.0	1.3	45.7

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] The figures for fertilizer are in weights of materials (urea, phosphate, and potash), not in nutrients, which are difficult to measure accurately in the absence of information on the use of these different types of fertilizer. An approximate nutrient content may be obtained by multiplying the figures by 0.46.

facilities were developed early (in the 1960s) by the Comilla cooperative movement. The consumption of chemical fertilizer ranges from almost insignificant in the villages in Khulna to about 130 kilograms per cropped acre in the villages in Comilla and is highly related to the proportion of area under MVs.

One method used in this paper to assess the impact of technology is to compare mean values of the variables in the technologically developed and underdeveloped villages. Since only about one-fifth of the area in Bangladesh had irrigation facilities at the time of the survey, a 20 percent irrigated area was used as the cutoff figure for classifying the villages into two groups. This also divides the sample into two equal size groups, with eight villages and 317 households in each group. In the developed villages more than 60 percent of the cropped land was sown with MVs of rice, compared with only 5 percent in the underdeveloped villages. The developed villages used 82 kilograms of fertilizer per acre of cropped land compared with 11 kilograms for the underdeveloped ones (Table 1).

The pattern of land distribution for the sample households is shown in Table 2. About 30 percent of the households own up to 0.5 acre, which is considered in Bangladesh as functionally landless. This category is estimated by the recent agricultural census of Bangladesh (1983-84) at 46 percent.[14] At the other end, about 10 percent of the households own 5.0 acres or more; these are large farmers by the Bangladesh standard. Their proportion for the country as a whole is estimated at 8.5 percent. The

---

[14] Bangladesh, *Census of Agriculture and Livestock*, p. 81.

Table 2—Distribution pattern of landownership in sample, 1982

Landownership Group	Number of Samples	Share of Households	Share of Land Owned	Share of Population	Average Amount of Land Owned
(acres)		(percent)	(percent)	(percent)	(acres)
Developed area	317	100.0	100.0	100.0	2.26
Less than 0.5	97	30.6	2.0	25.6	0.17
0.5–2.5	103	32.5	16.6	29.6	1.16
2.5–5.0	80	25.2	36.1	28.6	3.24
5.0–7.5	20	6.3	16.7	8.2	5.90
7.5 or more	17	5.4	28.6	8.0	12.07
Underdeveloped area	317	100.0	100.0	100.0	2.26
Less than 0.5	94	29.7	2.0	23.1	0.15
0.5–2.5	111	35.0	17.4	33.8	1.13
2.5–5.0	81	25.6	38.1	29.1	3.37
5.0–7.5	17	5.4	14.8	6.6	6.24
7.5 or more	14	4.4	27.7	7.4	14.17
Total sample	634	100.0	100.0	100.0	2.26
Less than 0.5	191	30.1	2.0	24.4	0.15
0.5–2.5	214	33.8	17.0	31.7	1.14
2.5–5.0	161	25.4	37.1	28.8	3.31
5.0–7.5	37	5.8	15.7	7.4	6.10
7.5 or more	31	4.9	28.1	7.8	13.02

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.
Note: Parts may not add to totals because of rounding.

average size of landownership for the sample is 2.26 acres, compared with 2.0 acres for Bangladesh. Thus the degree of landlessness is lower and the amount of land owned is higher for the sample than for Bangladesh. The pattern of land distribution is, however, very similar in the technologically developed and underdeveloped villages. The two groups have the same average size of landownership and the same proportion of landless households. The proportion of large farmers and their share of total land is, however, slightly higher in the developed villages. The proportion of area cultivated by tenants varies widely across villages, but the averages for the two groups of villages are similar (Table 1).

As a background to the detailed microlevel analysis that follows, Chapter 3 gives an overview of the technological progress in Bangladesh and its impact on agricultural growth and on trends in relative prices, using national data for 1950-85. The characteristics of modern varieties of rice vis-à-vis traditional ones, in terms of the use of various inputs and the implications for cost of production and profits, are described in Chapter 4, using detailed input-output information provided by the IFDC survey. The impact of technology on the productivity of land and labor and on the efficiency of resource use is analyzed in Chapter 5 through estimation of production functions and profit functions. Chapter 6 is a study of the effect of farm size and tenure on adoption of the new technology in order to assess the consequences of technological progress on the distribution of income among various groups of farmers.

To complete the assessment of equity implications of the technological diffusion, the employment effects are traced in Chapter 7 by an analysis of the supply of and demand for labor for different groups of households in the technologically developed and underdeveloped villages. Estimates of labor supply functions with disaggregated household information and of the effect of technological change on the agricultural wage rate are also given in this chapter. The issue of the indirect effects of the new technology on generation of employment and income for the poor through expansion of the market for nonfarm goods and services is taken up in Chapter 8, and the investment behavior of different landholding groups and the effects of growth of income on the land market are analyzed. The effects of technology on the level and distribution of income and on alleviation of rural poverty are summarized in Chapter 9. Finally, the implications of the major findings of the study for policies to promote rural development are discussed in Chapter 10.

3

TECHNOLOGICAL PROGRESS AND GROWTH OF CROP PRODUCTION—A MACRO PICTURE

Resource Base and the Need for Technological Progress

Continuous high growth of population has made Bangladesh an extremely land-scarce country, and land can no longer be counted as an important source of growth of agricultural production. The total area of the country is 35 million acres, of which about 60 percent is cultivated and most of the remainder is under forests, rivers, and homesteads (see Table 3). There has been little increase in cultivated land since the early 1950s (see Figure 1), and by the end of the 1960s, a type of equilibrium had been reached in the land use pattern that has since changed very little. During 1980-85, the wasteland that could be reclaimed for cultivation was only 1.9 percent of total land.

The effective supply of land could, however, be raised by growing additional crops on the same land during the year. This is indeed one of the means by which production has been increased from this limited resource base. In the early 1950s, only one-fourth of the total land was cropped more than once during the year. The intensity of cropping increased very rapidly in the 1960s—from about 130 percent in 1960/61 to 148 percent by 1969/70. The cropping intensity continued to increase after independence in 1971, but the rate of increase has slowed down (Figure 1 and Table 4). Further increase would depend on expansion of irrigation facilities, which allow the growing of additional crops on seasonally fallow land during the dry winter season (boro).

The majority of the people continue to depend on land for their livelihood because of limited expansion of nonagricultural sectors. Such expansion is inhibited partly by the small size of internal markets for nonagricultural goods and services and is perpetuated by low levels of income. The value added that is generated by manufacturing

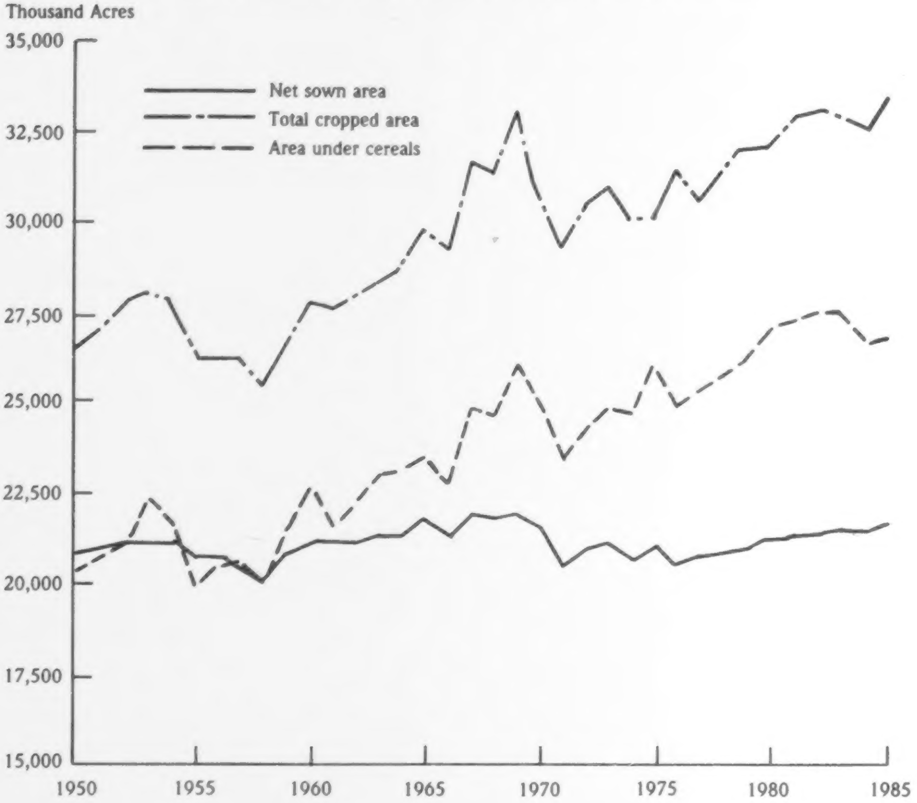
Table 3—Changes in pattern of land use, 1950-85

	1950-53		1967-70		1980-85	
Land Use	**Area**	**Share of Total**	**Area**	**Share of Total**	**Area**	**Share of Total**
	(million acres)	(percent)	(million acres)	(percent)	(million acres)	(percent)
Cultivated land	20.7	58.7	21.7	61.5	21.3	60.0
Current fallow	1.6	4.4	0.8	2.1	1.3	3.6
Cultivable waste	2.1	5.8	0.9	2.5	0.7	1.9
Forest	5.5	15.7	5.5	15.7	5.3	15.0
Not available for cultivation (rivers, canals, homesteads, etc.)	5.4	15.3	6.4	18.2	6.9	19.2
Total land	35.3	100.0	35.3	100.0	35.4	100.0

Sources: Based on data from Pakistan, Central Statistical Office, *25 Years of Pakistan in Statistics* (Karachi: Government Press, 1972); and Bangladesh, Bureau of Statistics, *Statistical Pocket Book of Bangladesh, 1986* (Dhaka: Ministry of Planning, 1987).

Note: Parts may not add to totals because of rounding.

Figure 1—Trends in cultivated area and cropped area, 1950-85



is only about 10 percent of the gross domestic product, and the share of construction, trade, and transport services is another 20 percent. The 1983/84 labor force survey has recorded that only 8 percent of the civilian labor force is employed in manufacturing, 17 percent in construction, trade, and transport services, and 12 percent in other services.[15] Agriculture still provides employment to about 60 percent of the labor force.

Owing to the population pressure and lack of nonagricultural employment, the land is cultivated in very small holdings. Also, holdings are fragmented into many scattered plots because of Islamic laws of property inheritance. The 1977 agricultural census found that two-fifths of the farms had more than 10 fragments.[16] The small farm, defined as under 2.5 acres, is the dominant production unit. With traditional technology, such a farm is incapable of producing a subsistence income, so most small farmers also work as agricultural wage laborers and engage in various nonfarm activities during

---

[15] Bangladesh, Bureau of Statistics, *Final Report: Labour Force Survey, 1983-84* (Dhaka: Ministry of Planning, 1986).

[16] Bangladesh, Bureau of Statistics, *Report on the Agricultural Census of Bangladesh, 1977* (Dhaka: Ministry of Planning, 1981).

Table 4—Changes in intensity of land use, 1950-85

Intensity of Use	1950-53		1967-70		1980-85	
	Area	Share of Total Cultivated Land	Area	Share of Total Cultivated Land	Area	Share of Total Cultivated Land
	(million acres)	(percent)	(million acres)	(percent)	(million acres)	(percent)
Single-cropped	14.6	70.5	12.6	58.1	11.4	53.5
Double-cropped	6.1	29.5	7.9	36.4	8.2	38.5
Triple-cropped			1.2	5.5	1.6	7.5
Total cropped area	26.8	129.5	32.0	147.4	32.7	153.5

Sources: Based on data from Pakistan, Central Statistical Office, *25 Years of Pakistan in Statistics* (Karachi: Government Press, 1972); and Bangladesh, Bureau of Statistics, *Statistical Pocket Book of Bangladesh, 1986* (Dhaka: Ministry of Planning, 1987).

Note: Parts may not add to totals because of rounding.

slack agricultural seasons to augment the income from farming. The proportion of small farmers increased from about a half in 1960 to over two-thirds by 1983/84, and they now cultivate about a third of total land (see Table 5). During the same period, the proportion of large farmers declined from 11 to 5 percent and the area operated by them fell from two-fifths to one-fourth of total land. The above landholding characteristics imply that there are few farmers who can generate enough surplus for reinvestment in agriculture, particularly in indivisible assets such as irrigation equipment.

While land is extremely scarce, Bangladesh is known to have abundant water resources, for which planned use in agricultural production was almost nonexistent even by the early 1960s. Three major rivers, the Ganges, the Brahmaputra, and the Meghna, and their numerous tributaries flow through Bangladesh and discharge huge volumes of water. Heavy rainfall and the geological structure produce excellent supplies of groundwater, which is available up to a depth of about 12 meters in most regions and at less than 6 meters in large parts of the country, and hence can be developed at relatively low cost. The recently completed National Water Plan estimates that nearly 40 percent of the cultivated land can be irrigated by development of surface water

Table 5—Changes in distribution pattern of landholdings, 1960-83/84

Farm Size	Share of Holdings		Share of Area Operated		Average Size of Farm	
	1960	1983/84	1960	1983/84	1960	1983/84
(acres)	(percent)		(percent)		(acres)	
Less than 1.0	24.3	40.4	3.2	7.8	0.47	0.44
1.0–2.5	27.3	29.9	13.0	21.2	1.68	1.60
2.5–5.0	26.3	18.0	26.4	27.5	3.55	3.45
5.0–7.5	11.4	6.8	19.3	17.6	6.00	5.91
7.5 or more	10.7	4.9	38.1	25.9	12.60	11.85
All farms	100.0	100.0	100.0	100.0	3.54	2.26

Sources: Based on data from Pakistan, Agricultural Census Organization, *1960 Census of Agriculture* (Karachi: Government Press, 1962), vol. 2, *East Pakistan;* and Bangladesh, Bureau of Statistics, *The Bangladesh Census of Agriculture and Livestock: 1983-84,* vol. 1 (Dhaka: Ministry of Planning, 1986).

through water conservation measures and withdrawing of streamflows from rivers.[17] The groundwater resource potential is estimated, on the basis of 75 percent usable recharge, at 17,140 million cubic meters, which can irrigate about 9.4 million acres, or about 45 percent of the cultivated land. Currently only about 20 percent of total land is irrigated. Obviously, there is a vast potential for further development of water resources in the country.

The new varieties of rice and wheat, developed by the international agricultural research stations and introduced to farmers in Bangladesh in the late 1960s, opened up the possibility of increasing the food supply on the limited land through development of water resources. The new varieties produce a substantially higher amount per unit of land compared with the traditional varieties, but they need careful water management and large amounts of chemical fertilizer, without which they fare no better than traditional varieties. Thus, production could be increased by shifting land from traditional to modern varieties (popularly known as "seed-fertilizer" technology), provided the land has access to flood control, drainage, and irrigation facilities. At the same time, expansion of irrigation facilities would increase the effective supply of land during the dry winter season when a large proportion of land is kept fallow because of inadequate moisture in the soil. The diffusion of new technology supported by the development of water resources is thus the key to maintaining the food-population balance in the country.

Diffusion of Modern Technology

The New Seeds

Experiments in the management of rice seed improvement have been conducted at the Dhaka Research Station since 1911, but a set of MVs was imported in the late 1960s to support the accelerated food production program sponsored by the Ford Foundation.[18] During the 1970s, large quantities of MV seeds were imported from the International Rice Research Institute (IRRI) in the Philippines and from India.

In 1970 the Bangladesh Rice Research Institute (BRRI) was set up to develop varieties better suited to local growing conditions. By 1983, BRRI had introduced 16 short-duration modern varieties. The newer varieties have yield rates similar to the earlier ones, but are superior in disease resistance ~~and grain quality. Rice is grown~~ in three distinct seasons: aus (April to August), aman (August to December), and boro (January to May). The new varieties have been introduced in all three seasons. In addition, a number of improved wheat varieties have been imported from the Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT) in Mexico and from India and have been propagated on the seed multiplication farms of the Bangladesh Agricultural Development Corporation (BADC) for distribution among farmers. The most popular wheat variety is Sonalika, which was bred in India with materials from CIMMYT and its predecessors based on Mexican material.[19]

---

[17] Bangladesh, Master Plan Organization, *National Water Plan Project: Draft Final Report,* vols. 1 and 2 (Dhaka: Ministry of Irrigation and Flood Control, 1985).

[18] Dana G. Dalrymple, *Development and Spread of High Yielding Rice Varieties in Developing Countries* (Washington, D.C.: U.S. Agency for International Development, 1986), p. 39.

[19] Carl E. Prey and Jock R. Anderson, *Bangladesh and the CGIAR Centers: A Study of Their Collaboration in Agricultural Research,* Study Paper 8 (Washington, D.C.: World Bank, 1985), p. 43.

The official statistics on the expansion of area under modern seed varieties of rice and wheat are given in Table 6. The figures show that use of the new seeds was negligible up to the end of the 1960s, but picked up rapidly in the 1970-74 period, which was followed by stagnation during 1974-78. The expansion, however, resumed during 1978/79 and continued through 1984/85 at a rate of about 600,000 acres a year, which doubled the area covered by the new seeds within seven years.

The apparent stagnation in the MV area in the mid-1970s may be statistical rather than real. The Ministry of Agriculture set up task forces in 1974 and 1975 to evaluate the progress of MV aman and wheat programs, and their field investigations revealed substantial overreporting of MV aman acreage and minor underreporting of MV wheat acreage.[20] Recognizing that the early information on MV expansion was overreported, the Bangladesh Bureau of Statistics made substantial downward adjustments in the area under aman and boro MVs for 1974/75-1976/77.[21] In view of this adjustment it could be argued that the diffusion of new seed varieties has proceeded steadily since their introduction in the late 1960s.

By 1985 nearly one-third of the cereal area had been covered by the new seeds. Nearly two-thirds of the MV area is cropped during the overlapping boro and aus

Table 6—Expansion of area under modern-variety (MV) seeds, 1967-86

	Rice MVs				Rice and Wheat MVs	
Year	Boro Season	Aus Season	Aman Season	Wheat MVs	Total Area	Share of Total Rice and Wheat Area
		(1,000 acres)		(1,000 acres)	(1,000 acres)	(percent)
1967/68	156	. . .	. . .	. . .	156	0.6
1968/69	361	17	. . .	. . .	378	1.5
1969/70	580	43	29	. . .	652	2.5
1970/71	857	79	200	. . .	1,136	4.6
1971/72	793	121	625	. . .	1,539	6.7
1972/73	1,087	163	1,378	52	2,680	11.1
1973/74	1,455	329	2,043	72	3,899	15.8
1974/75	1,630	699	1,240	82	3,651	14.9
1975/76	1,588	872	1,376	217	4,053	15.7
1976/77	1,338	902	1,046	288	3,574	14.2
1977/78	1,586	981	1,233	388	4,188	16.6
1978/79	1,650	1,055	1,694	583	4,892	19.4
1979/80	1,788	994	2,154	1,015	5,953	22.7
1980/81	1,845	1,200	2,376	1,412	6,833	25.4
1981/82	2,218	1,166	2,361	1,277	7,022	25.8
1982/83	2,670	1,175	2,653	1,231	7,729	28.2
1983/84	2,635	1,235	2,628	1,475	7,973	28.3
1984/85	3,040	1,151	2,669	1,622	8,482	31.5
1985/86	2,998	1,191	2,906	1,291	8,386	31.0

Sources: Based on data from Bangladesh, Bureau of Statistics, *Yearbook of Agricultural Statistics*, various issues (Dhaka: Ministry of Planning, various years); and Bangladesh, Bureau of Statistics, *Monthly Statistical Bulletin of Bangladesh*, various issues.

---

[20] Bangladesh Agricultural Development Corporation, *HYV Task Force Reports, 1974/75* (Dhaka: BADC, 1977).

[21] See Mahabub Hossain, "Foodgrain Production in Bangladesh: Performance, Potential and Constraints," *The Bangladesh Development Studies* 8 (Nos. 1 and 2, 1980): 39-70.

seasons, when the crops are grown with irrigation. About 97 percent of the area under wheat has been covered by MVs, which have expanded largely at the expense of minor dry season crops such as oilseeds and pulses. The MV wheat area, however, constitutes only 15 percent of the MV cereal area. For rice, the coverage is about 78 percent for the boro season, 16 percent for the aus season, and 20 percent for the aman season. A major constraint to expansion of the MV area during the aman season is that more than two-thirds of the area remains under deep water throughout the season and is not suitable for growing the dwarf MVs.

Development of Irrigation Facilities

Before modern irrigation was introduced in Bangladesh, cultivators used to irrigate boro paddy by lifting surface water through such traditional devices as swing baskets and *dhones.* The 1960 agricultural census estimated that in 1959/60 nearly 7 percent of the cultivated land received irrigation by these traditional methods, mostly concentrated in the depressed basins of Sylhet, Mymensingh, and Rajshahi districts, where surface water was available at a height of 1-2 meters below the field during the driest months of the year.[22] The subsequent development of modern irrigation has partly replaced these traditional sources of irrigation, and the area under traditional irrigation reportedly declined from about 1.5 million acres in 1970/71 to 0.9 million acres by 1984/85.[23]

The initiative for development of modern irrigation facilities had been taken by the government, since farmers were unwilling or unable to make large, lump-sum investments in irrigation equipment. The major constraint has been the small average size of farms and the fragmented holdings. During 1976-84 the government expenditure for development activities in the agricultural sector was Tk 7,720 million a year, of which Tk 3,200 million (42 percent) was spent for irrigation and flood control.[24] The projects were financed mainly with foreign aid.

The government's earliest approach to expansion of irrigation facilities was through construction of large-scale multipurpose irrigation, flood control, and drainage projects carried out by the Bangladesh Water Development Board (BWDB). A number of major projects built during the 1960s and 1970s have been largely successful in protecting coastal and river belt areas from saline-water intrusion and floods, but they played only a minor role in the irrigation development of the country. The area irrigated by such projects constitutes only about one-tenth of the total area irrigated in Bangladesh. The provision of irrigation through the BWDB projects has been costly, since both the capital and current costs are borne almost entirely by the government.[25]

Most irrigation development in Bangladesh has taken place through use of small-scale equipment such as low-lift pumps, deep tubewells, and shallow tubewells. Up to the mid-1970s, expansion followed upon subsidized rental to farmers' cooperatives of low-lift pumps with a capacity of 1-2 cubic feet per second (see Table 7). The number of pumps under operation rose quickly from about 3,000 in 1965/66 to about 35,000 by 1973/74, but expansion since then has been slow. In 1978/79 the government

---

[22] Pakistan, Agricultural Census Organization, *1960 Pakistan Census of Agriculture,* vol. 1, *East Pakistan* (Karachi: Ministry of Food and Agriculture, 1962).

[23] Bangladesh, Bureau of Statistics, *Yearbook of Agricultural Statistics* (Dhaka: Ministry of Planning, 1982); and Bangladesh, Bureau of Statistics, *Monthly Statistical Bulletin of Bangladesh,* March 1986.

[24] At the 1984/85 official rate of exchange, US$1.00 = Tk 30.

[25] See Siddiqur R. Osmani and M. Abul Quasem, "Pricing and Subsidy Policies for Bangladesh Agriculture," Bangladesh Institute of Development Studies, Dhaka, 1985 (mimeographed), pp. 134-137.

Table 7—Development of modern irrigation facilities, 1960-85

Year	Units of Irrigation Equipment Under Operation			Area Irrigated by Modern Methods[a]		Total Area Irrigated	
	Low-lift Pumps	Deep Tubewells	Shallow Tubewells	Acres	Share of Cultivated Land	Acres	Share of Cultivated Land
		(thousands)		(thousands)	(percent)	(thousands)	(percent)
1960/61	1.4	. . .	. . .	62	0.3	1,433	7.0[b]
1965/66	3.4	. . .	. . .	200	0.9	n.a.	n.a.
1969/70	17.9	1.0	. . .	830	3.8	2,613	12.0
1973/74	35.3	1.5	1.0	1,501	7.2	3,201	15.3
1974/75	35.5	2.7	2.4	1,564	7.5	3,562	17.0
1975/76	36.4	3.8	4.0	1,606	7.6	3,458	16.5
1976/77	28.2	4.5	5.4	1,341	6.6	3,004	14.7
1977/78	36.7	7.5	12.3	1,951	9.4	3,223	15.8
1978/79	35.9	9.3	17.0	2,295	11.0	3,903	18.9
1979/80	37.4	9.8	22.4	2,638	12.6	4,226	20.3
1980/81	36.1	10.1	38.4	3,033	14.3	4,520	21.4
1981/82	38.2	11.5	66.5	3,626	17.1	5,076	23.9
1982/83	42.2	13.8	104.1	4,036	19.0	5,345	25.1
1983/84	43.7	15.5	109.7	4,313	20.2	5,432	25.4
1984/85	49.8	16.7	137.0	4,579	21.5	5,483	25.7

Sources: Based on data from Bangladesh Agricultural Development Corporation, *Annual Report,* various issues (Dhaka: Government Press, various years); Bangladesh, Ministry of Finance, *Bangladesh Economic Survey,* various issues (Dhaka: Government Press, various years); Bangladesh Agricultural Development Corporation, "Sale of Shallow Tubewells in the Northwest and South-eastern Districts of Bangladesh," BADC, Dhaka, 1984 (mimeographed); and Pakistan, Agricultural Census Organization, *1960 Census of Agriculture* (Karachi: Government Press, 1962), vol. 2, *East Pakistan.*

Note: n.a. means not available.

[a] Figures for shallow tubewells include those fielded by the Bangladesh Krishi Bank, as estimated in Bangladesh Agricultural Development Corporation, "Sale of Shallow Tubewells." The area irrigated as reported in this table exceeds the figure provided by the Bangladesh Bureau of Statistics because of this discrepancy, as the latter did not include the area irrigated by these shallow tubewells.

[b] For 1959/60, as estimated in Pakistan's 1960 agricultural census.

started selling pumps to individual farmers and cooperatives. The subsidy remains at about 30 percent of the procurement cost.[26]

The promotion of groundwater development started late, beginning in 1967/68, and moved at a slow pace through 1977/78. Initially, deep tubewells were rented to bona fide farmers' cooperatives, which formed groups of water-users with contiguous plots totaling at least 50 acres. The groups would bear the operation cost and pay a highly subsidized pump rental to BADC. Beginning in 1978/79, the government started selling deep tubewells to groups and private individuals at a subsidy of about 70-80 percent. The number of deep tubewells increased gradually from 800 in 1970/71 to about 4,500 by 1976/77 and then more rapidly to about 16,700 by 1984/85.

The spurt of expansion of irrigation, however, began in the mid-1970s with the promotion of small-capacity (less than 0.5 cubic foot per second) shallow tubewells. From the beginning, these were sold to farmers almost at cost, but most of the purchases were financed by loans from the Bangladesh Krishi Bank (agricultural development bank), a large proportion of which were not repaid. The sales of shallow tubewells increased rapidly during 1979-83 but have slackened since then. The tubewells now account for over half of the total irrigated area in the country.

---

[26] Osmani and Quasem, "Pricing and Subsidy Policies," pp. 291-296.

The reasons behind the slowdown of the sales of minor irrigation equipment have not yet been investigated thoroughly. It is conjectured that the tightening of disciplines regarding recovery of institutional loans and reduction in farmers' cash income due to low prices of jute may be the major factors. Further expansion may also be constrained because relatively large farms that can afford private investment in irrigation equipment have already been covered, and the government will have to tackle the more difficult problem of organizing the small and medium farms into cooperatives. The 1983-84 agricultural census found that only 89,000 rural households owned more than 15 acres of land (the command area of a shallow tubewell), and according to a World Bank estimate, there are already more than 170,000 shallow tubewells in the country.[27]

Official statistics on the area irrigated by different methods are known to be of dubious quality. The figures provided by different agencies in charge of irrigation development are not consistent with the figures published by the Bangladesh Bureau of Statistics, which probably underestimates the area irrigated by shallow tubewells sold through the private sector by the Bangladesh Krishi Bank. It is also reported in a number of field surveys that some of the equipment sold to farmers may be used for nonagricultural purposes.[28] The margin of error, however, may not be very large, as the 1983-84 agricultural census estimates the irrigated area at 1.62 million acres, against the official estimate of the area irrigated by modern methods at 1.75 million acres for that year.

The time series data on irrigated land, compiled from the figures released by BADC, BWDB, and the Ministry of Finance, are represented in Table 7. Modern irrigation, though almost negligible through the late 1960s, has developed rapidly since 1977/78. Still, only about one-fourth of the cultivated area is irrigated and about one-fifth is irrigated by modern methods. The potential for further development of irrigation is thus considerable.

Economic analysis of various modes of irrigation conducted by the National Water Plan on the basis of (1) the observed cropping pattern and input-output coefficients, and (2) shadow prices of inputs and output, gives a rate of return on investment of 35 percent for large flood control, drainage, and irrigation projects and more than 90 percent for minor irrigation equipment.[29] The incentive for farmers to invest in small-scale irrigation equipment has also been examined by the National Water Plan, using a cash-flow analysis, at the existing terms of loans from the financial institutions. The analysis shows that individual farmers have enough incentives to invest in shallow tubewells and low-lift pumps, but for deep tubewells private investment is not financially feasible at existing terms. However, investment through cooperatives provides ample financial incentives.

In spite of high profitability, the government achieved only 25 percent of the planned targets for irrigation expansion during the First Five-Year Plan (1973-78), and 71 percent during the Second Five-Year Plan (1980-85). The major constraints to expansion of irrigation seem to be (1) poor financial capacity owing to the low income of the farmers, low tax-GNP ratio, and inability of the government to recoup the investment cost from the beneficiary; (2) low implementation capacity of public institutions, which often leads to time and cost overruns in project implementation; (3) differential pricing of water by BADC and BWDB and of different equipment by BADC, all of which may dampen private initiatives for investment; (4) high unit costs on account of variable inputs due to low-capacity utilization of equipment; (5) lack of proper zoning of areas suitable for different equipment, which may result in improper siting that leads to low-capacity utilization; and (6) organizational problems in forming cooperatives of water users.

---

[27] Bangladesh, *Census of Agriculture and Livestock.*

[28] See, for example, M. Abdul Hamid, *Low-Lift Pumps under IDA Credit in South-East Bangladesh: A Socio-Economic Study,* Rural Development Studies, Series 12 (Rajshahi: Rajshahi University, Department of Economics, 1984).

[29] Bangladesh, *National Water Plan Project.*

Fertilizer Consumption

Although chemical fertilizers were introduced into Bangladesh in the 1950s, their application was mostly limited to tea gardens and government experimental farms until the early 1960s. With the objective of popularizing this new input to farmers, BADC, a parastatal organization established for procurement and distribution of modern agricultural inputs to farmers, started selling fertilizers to farmers at highly subsidized prices. It is estimated that in 1968/69 the average rate of subsidy was about 58 percent for urea and phosphate, and 67 percent for potash.[30] With rapidly increasing sales, the subsidy rates began to put a heavy burden on the government budget in the early 1970s. This burden, together with an increase in the procurement cost of fertilizers, led the government to reduce subsidies. By 1983/84 the budgetary subsidy was reduced to about 25 percent of the cost, and the economic subsidy valued at border prices was about 23 percent in that year.[31] At present, there is little subsidy on fertilizer. During 1972-84 fertilizer prices increased by 20 percent a year, compared with a 10 percent increase in the prices of crop output. Another policy change introduced since 1978 is the handing over of fertilizer distribution at the local level from BADC to private traders. Under the new system, traders can buy fertilizer from BADC sales centers at the government-fixed prices and sell it to farmers at a market-determined price. BADC still keeps control over procurement of fertilizers and distribution to primary sales points and, for that purpose, also plans supply to maintain adequate stocks.

The trend in consumption of fertilizers can be reviewed in Table 8. In 1960/61 consumption was almost negligible at less than 1 kilogram of nutrient per acre of sown area. By the end of the 1960s, consumption had increased to over 4 kilograms per acre and it tripled within the next decade to about 13 kilograms in 1979/80. After a brief period of stagnation during 1979-83, consumption picked up again from 1983 to 1985. Sales in 1984/85 reached 1.26 million metric tons[32] of fertilizers valued at about 5.3 percent of the value added in crop production. During 1970-85, the trend rate for growth of consumption was about 10 percent a year.

Time series data for fertilizer application on crops are not available for Bangladesh. Trends of use in different seasons could, however, be constructed from BADC sales figures, which are available by months. Fertilizer is applied on the main aman paddy crop from July to October, when no other fertilizer-using crops are widely cultivated. November to March is the fertilizer application season for various rabi crops such as

---

[30] F. Kahnert et al., *Agriculture and Related Industries in Pakistan* (Paris: OECD Development Center, 1970).

[31] Raisuddin Ahmed, "Structure, Dynamics, and Related Policy Issues of Fertilizer Subsidy in Bangladesh," in Bangladesh Institute of Development Studies/International Food Policy Research Institute, *Fertilizer Pricing and Foodgrain Production Strategy in Bangladesh, Technical Annex* (Washington, D.C.: IFPRI, 1985).

[32] All tons referred to in this report are metric tons.

Table 8—Trends in consumption of chemical fertilizers, by season, 1960/61-1984/85

	Total Fertilizer Sales				Sales per Unit of Cropped Land	
Year	Aman Season	Boro Season	Aus Season	All Seasons	All Seasons	Boro Season
	(1,000 metric tons)				(kilograms of nutrients/acre)	
1960/61	20	13	16	49	0.9	2.6
1965/66	45	28	35	108	1.7	5.3
1970/71	109	130	70	309	4.6	15.2
1973/74	109	200	81	390	5.9	22.1
1975/76	139	234	92	465	7.0	24.1
1976/77	154	227	140	521	8.0	24.9
1977/78	207	325	195	727	10.9	33.0
1978/79	256	358	140	754	11.1	35.7
1979/80	252	424	179	855	12.5	37.6
1980/81	265	429	195	889	12.8	35.2
1981/82	291	392	160	843	12.1	30.9
1982/83	245	507	216	968	13.7	38.0
1983/84	267	629	233	1,129	16.1	47.3
1984/85	364	669	228	1,261	18.1	44.8

Sources: Based on data from Bangladesh Agricultural Development Corporation, *Annual Report*, various issues (Dhaka: Government Press, various years); and Bangladesh, Bureau of Statistics, *Monthly Statistical Bulletin of Bangladesh*, various issues.

potato, wheat, mustard, and sugarcane, and also for boro paddy, which is grown under irrigated conditions. Aus paddy and jute are treated with fertilizer from April to June. The constructed time series data on season-specific consumption of fertilizer, reported in Table 8, show that the major focus of growth of fertilizer consumption has been on the boro and rabi crops cultivated during the winter season. Most of the area under MVs is also cultivated during this season. These crops now account for about one-fourth of the sown area, but sales during the 1984/85 season accounted for over half of the total fertilizer sales in the country. The present application rate of fertilizer on boro season crops is about 3.5 times higher than that for all crops taken together (Table 8). It is estimated elsewhere[33] that the share of MV crops in total fertilizer consumption increased from about 25 percent in 1969/70 to over 61 percent in 1983/84. Of the total increase in consumption during 1977-84, 81 percent was associated with the increased use of MVs and 51 percent with increased use on irrigated land. Thus MV seeds and irrigation have played an increasingly important role in the growth of fertilizer consumption in Bangladesh.

Complementarity of the Modern Technology Package

The time series data reviewed above show a high degree of complementarity between irrigation, fertilizer use, and diffusion of MV seed (Figures 2 and 3).[34] But

---

[33] Mahabub Hossain, "Fertilizer Consumption, Pricing and Foodgrain Production in Bangladesh," in BIDS/IFPRI, *Fertilizer Pricing*, pp. 149-150.

[34] This section draws heavily from Mahabub Hossain, "Irrigation and Agricultural Performance in Bangladesh: Some Further Results," *The Bangladesh Development Studies* 14 (No. 4, 1986): 39-56. The main conclusions are also supported by James K. Boyce, "Water Control and Agricultural Performance in Bangladesh," *The Bangladesh Development Studies* 14 (No. 4, 1986): 1-35.

Figure 2—Expansion in modern irrigation and modern-variety seeds, 1960-84

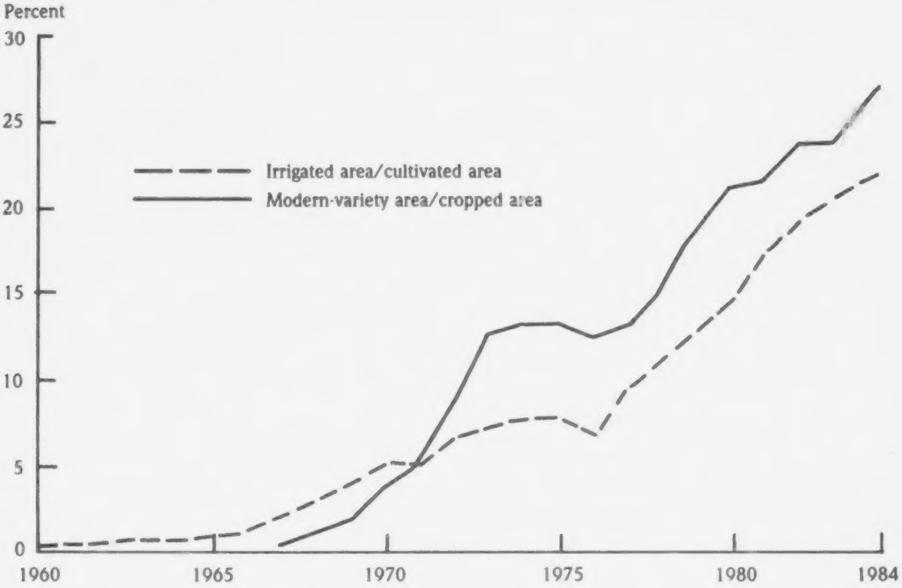
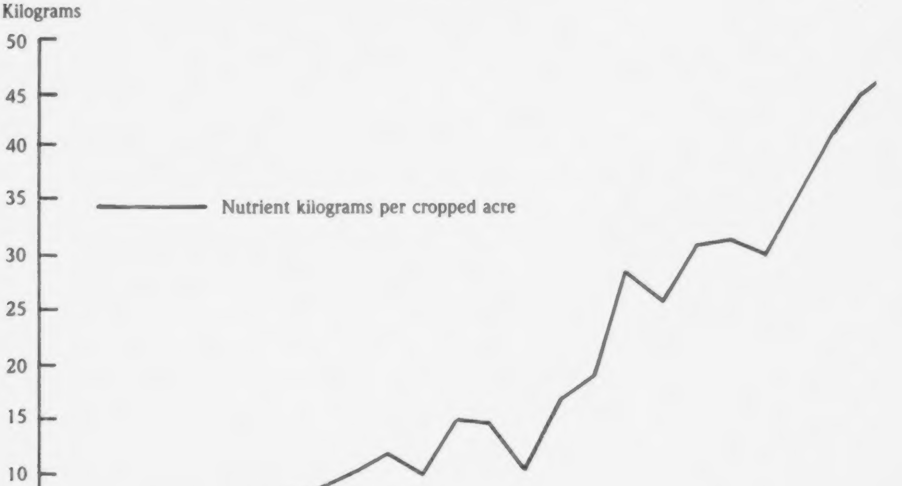


Figure 3—Trend in fertilizer use, 1960-84



irrigation could be the leading input in the sense that adoption of MVs and application of fertilizers follow development of irrigation facilities. The following analysis based on regional cross-section data for 1983/84, the latest normal year for which data are available, shows the nature of this complementarity and the leading role of irrigation.

A large variation in the diffusion of the new technology is found among the regions of Bangladesh. By 1984/85 the proportion of land irrigated by modern methods had increased to over one-third in the districts of Bogra, Kushtia, and Chittagong, while it was still less than 15 percent in the coastal districts of Patuakhali, Barisal, Khulna, and Noakhali. Similarly, the proportion of cereal area cultivated with MV seeds varied from 75 percent in Chittagong to less than 20 percent in Patuakhali, Barisal, Khulna, and Sylhet. Fertilizer consumption per acre of cultivated land varied from over 40 kilograms in the districts of Chittagong, Bogra, and Kushtia to less than 10 kilograms in the districts of Patuakhali, Barisal, Khulna, Faridpur, and Sylhet.

The relationship between the intensity of fertilizer consumption and the percentage of net sown area irrigated is shown by regression equations in Table 9, estimated by the ordinary least square (OLS) method on the district-level cross-section data. To reduce specification errors, important structural factors that differ across districts, such as annual rainfall, land elevation, and average farm size, have been used as additional

Table 9—Association of fertilizer consumption and adoption of modern varieties (MVs) with irrigation, 1983/84

	Regression Coefficient of Independent Variables						
		Share of Cultivated Area Irrigated					
Dependent Variables	Constant Term	Total	Modern Methods	Rainfall Deviation from Normal[a]	Share of Medium-High Land	$\bar{R}^2$	'F' Statistics
		(percent)			(percent)		
Fertilizer consumption (kilograms per acre)	8.27 (0.43)	5.81 (5.31)	...	−0.22 (−0.29)	−0.54 (−1.57)	0.60	10.5
	7.74 (0.54)	...	6.07 (7.71)	−0.30 (−1.18)	0.11 (0.20)	0.77	21.7
	5.77 (0.83)	...	5.87 (8.11)	...	...	0.79	65.8
Percent of cultivated area under dry-season MVs (boro rice and wheat)	5.82 (1.79)	0.86 (5.92)	...	−0.07 (−1.52)	−0.03 (−0.26)	0.67	14.1
	5.88 (1.31)	...	0.89 (8.83)	−0.03 (−1.02)	−0.04 (−0.61)	0.82	30.5
	2.44 (1.12)	...	0.89 (9.65)	...	...	0.83	93.2
Percent of cultivated area under wet-season MVs (aus plus aman)	22.71 (−1.69)	...	0.49 (1.92)	0.16[a] (3.16)	−0.09 (−0.47)	0.41	5.4
	22.71 (−2.27)	...	0.53 (2.28)	0.15[a] (3.23)	...	0.44	8.4

Notes: Estimates are from district-level data. The sample size is 20 Bangladesh (old) districts. Figures in parentheses are estimated t-values.

[a] The variable is measured by the amount of annual rainfall in the district.

explanatory variables. The farm size variable was found to be statistically insignificant in all estimating equations and hence it was dropped. Since both too much and too little rainfall can affect fertilizer use, the absolute deviation of rainfall in the district from normal rainfall in Bangladesh has been used. The land elevation variable has been measured by the percentage of area under medium-high land in the district, as recorded in the 1977 agricultural census.[35] Two alternative irrigation variables have been used—total area irrigated and area irrigated by modern methods. Although most of the data are now available for 1984/85, the reference year for this analysis is 1983/84, which was chosen because the 1984/85 aus and aman crops were affected by a number of abnormal floods during July-September 1984, while 1983/84 was a relatively normal year.

The estimated equations show that the structural factors (rainfall and land elevation) do not influence fertilizer consumption or adoption of MVs during the dry season. Both these variables are, however, strongly correlated with the level of irrigation. A better statistical fit is obtained with modern irrigation than with traditional irrigation. This is expected because traditional irrigation is practiced mostly in the depressed basins of the country and is the outcome of the natural endowment of land and water rather than of a conscious investment decision by the farmer or the state. The low-lying areas remain unsuitable for growing any crop during the monsoon season and are used for growing local boro during the dry season when the water level is reduced, but deep flooding still does not allow adoption of MVs or economic use of fertilizer.

The estimated equations that contain only the statistically significant variables show that irrigation alone explains about 79 percent of the regional variation in fertilizer consumption and about 83 percent of the variation in diffusion of MVs during the dry season. The elasticity of fertilizer consumption in relation to irrigation is estimated from the equation at 0.90 at the mean level of use of these inputs, and the elasticity of MV adoption during the dry season is estimated at 0.89.

The area covered by MVs during the wet season is, however, more strongly associated with rainfall than with irrigation. Only about 44 percent of interdistrict variation in the coverage of MVs during the wet season is explained by these two variables. It appears that some other important determinants have not been incorporated in the analysis. One such variable may be the duration of the monsoon, since an early monsoon would facilitate adoption of aus MVs, and districts receiving adequate rainfall during the late monsoon period (September-October) may have a relative advantage in growing rain-fed aman MVs. The depth of flooding may be another variable.

The relatively weak relationship between irrigation and expansion of wet season MVs may be due to the initial spreading of MVs in districts that have favorable rainfall endowments and to the low-lift pump irrigation initially spread to low-lying areas where adequate surface water is available in the dry season, but deep flooding of such land during the wet season does not permit raising dwarf MVs. With increased extraction of groundwater resources by tubewells, irrigation facilities are now being extended to medium-high and high land areas, which could be used for providing supplementary irrigation required for raising MV aus and aman crops.

Development and use of modern irrigation facilities require prior capital investment and institutional arrangements for the coordination of actions among many cultivators. The adoption of MV seeds and application of chemical fertilizers are, however, current production decisions undertaken by individual cultivators. These special attributes of irrigation and the high degree of complementarity among the seed-water-fertilizer inputs in the new technology package suggest that development of irrigation poses the key constraint to diffusion of modern technology in Bangladesh. (This is discussed further in Chapter 6.)

---

[35] Bangladesh, *Report on the Agricultural Census, 1977.*

Impact on Growth

What has been the impact of technological progress on the growth of crop production? This section analyzes the official time series data on sown area and production of different crops for 1950-85 to see whether production growth has accelerated since the introduction of the new agricultural technology.

A large number of crops are grown in Bangladesh, but three crops—rice, wheat, and jute—account for nearly 90 percent of the total sown area. This analysis considers rice and wheat (cereal group), and jute, sugarcane, tobacco, pulses, oilseeds, potato, and chili (noncereal group). These crops accounted for about 94 percent of the sown area during 1980-85, so the exclusion of other crops should not seriously affect the results. The 1981/82 crop-level harvest prices have been used as weights for valuation of production at constant prices. In Bangladesh, prices fluctuate widely from year to year, particularly for minor crops, whose production is highly responsive to changes in relative prices.[36] The 1981/82 price level was chosen because, for most of the crops, it was very close to the trend for 1976-84.

The yield rates have been estimated by dividing the gross value of production by the sown area. To assess the impact of the new technology on growth, the time series has been divided into two parts, 1950-71 and 1971-85, and the growth performance of the two periods has been compared (see Figure 4). The crop year 1971/72 has been taken as the dividing line because, as noted earlier, little progress was made with the new technology through the late 1960s and, also, Bangladesh became independent of Pakistan in 1971 and a close scrutiny of the official series indicates that a downward adjustment has been made since 1971/72 in the crop-yield figures.

To see whether the growth rate has accelerated since 1971/72 with the diffusion of the new agricultural technology, the following trend equation has been fitted on the data for the entire period (1950-85):

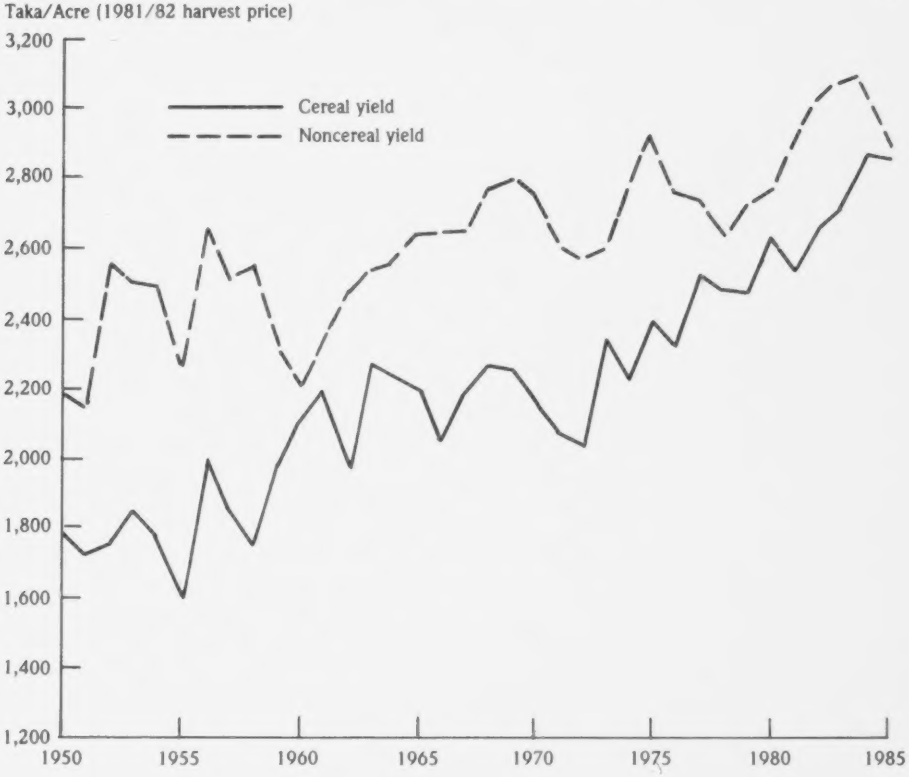
$$\mathrm{Ln}Y = a_0 + a_1D + b_0T + b_1DT + u,$$

where Ln is the natural logarithm of the variable, Y is the variable for which the rate of growth is estimated, D is the dummy variable, taking value one for 1971-85 and zero otherwise, and T is time. The rate of growth for 1950-71 is given by b_0 and that for 1971-85 is given by $(b_0 + b_1)$. The value of b_1 is expected to be positive if there has been an acceleration of growth during 1971-85. The coefficient of the dummy variable, a_1, will indicate whether any adjustment has been made in the time series since 1971.

---

[36] John T. Cumm[illegible]gs, "The Supply Response of Bangalee Rice and Cash Crop Cultivators," *The Bangladesh Development Studies* 2 (October 1974): 235-251; and Sultan H. Rahman, "Supply Response in Bangladesh Agriculture," *The Bangladesh Development Studies* 14 (No. 4, 1986): 57-100.

Figure 4—Trends in yield of cereal and noncereal crops, 1950-85



The growth rates derived from the estimated equations (see Appendix, Table 72) are presented in Table 10. The growth of production has accelerated from about 2.5 percent a year during 1950-71 to about 2.9 percent during 1971-85. This has taken place in spite of a deceleration in the growth of cropped land in the later period. The impact of technological progress should be felt on the growth of land productivity. It is estimated that the growth of yield rates has accelerated from 1.4 to about 2.0 percent a year for all crops. The acceleration coefficient is found to be statistically significant at about 5 percent probability level.

For investigation of the issue at hand, cereals are more important than noncereals, since technological progress has taken place mainly in the production of rice and wheat. The production of cereals has grown at faster rates than production of noncereal crops, and the difference in performance is particularly noticeable in the postmodern-technology period. The growth of production for cereal crops has accelerated from about 2.6 percent a year during 1950-71 to about 3.4 percent during 1971-85. The acceleration in production is mainly on account of the growth in crop yields, that is, land productivity, which has increased from 1.5 to 2.2 percent a year. The acceleration in the growth of productivity in the postmodern-technology period is almost twice as much for cereals

Table 10—Growth in crop production before and after introduction of modern technology

Crops/Period	Trend Rate of Growth		
	Cropped Land	Yield per Unit of Land	Production
		(percent/year)	
Cereal			
1950-71	1.10	1.52	2.62
1971-85	1.16	2.20	3.36
Noncereal			
1950-71	1.26	0.89	2.15
1971-85	−0.73	1.26	0.53
All			
1950-71	1.12	1.40	2.52
1971-85	0.90	2.02	2.92

Source: Derived from equations in Table 72, based on estimates from official statistics from Bureau of Statistics, Bangladesh.

as for noncereal crops. The acceleration coefficient for cereal yield is found to be statistically significant at 10 percent probability level.

The technological progress in cereal crops, however, has had adverse effects on the production of noncereal crops, many of which cannot compete with MVs of rice and wheat. The most seriously affected crops are jute, pulses, and oilseeds, whose cultivated area has declined consistently since the late 1960s. Jute competes for land with aus rice, but owing to a long-term decline in the price of jute relative to the price of rice, large fluctuation in its prices, and technological advances made in rice, some of the traditional jute land has been shifted to MV aus and boro crops. The expansion of cropped land under boro rice and wheat has been partly at the expense of pulses and oilseeds. It will be noted from Table 10 that cereal crops have maintained their growth in cropped land at about 1.1 percent a year, largely at the expense of noncereal crops, whose cultivated area declined absolutely at a rate of about 0.7 percent a year during 1971-85.

Level and Fluctuation of Food Prices

Technological progress implies a downward shift in the cost function (Chapter 4), and depending on the nature of demand, some of the benefits may be shifted to consumers in the form of lower prices. It is argued in the literature that one of the important ways through which technological progress indirectly benefits the poor is the lowering of real food prices.[37] So a relevant empirical question at this point is what has happened to the prices of cereals compared with those of noncereal crops since the introduction of modern technology.

---

[37] See Mellor, "Food Price Policy and Income Distribution"; and Yujiro Hayami and Robert W. Herdt, "Market Price Effects of Technological Change on Income Distribution in Semi-Subsistence Agriculture," *American Journal of Agricultural Economics* 59 (May 1977): 245-256. For Bangladesh the issue has recently been studied by Mohammad Alauddin and Clem Tisdell, "Market Analysis, Technical Change, and Income Distribution in Semi-Subsistence Agriculture: The Case of Bangladesh," *Agricultural Economics* 1 (No. 1, 1986): 1-18.

Table 11 presents estimates of the rate of increase in the retail prices of major commodities in the consumption basket for 1950-71 and 1971-85. Since prices fluctuate considerably from year to year, the rates of growth have been estimated by fitting semilogarithmic trend lines to the time series data. The rate of inflation, as measured by the trend rate of growth in the consumer price index, was only about 3 percent a year during the 1950s and 1960s but increased to about 11 percent after independence. So in comparing price changes for the two periods, the relative increase in prices, rather than the absolute increase, should be examined.

During the two decades before the introduction of the new technology, rice prices increased at a much faster rate (80 percent higher) than the general rate of inflation in Bangladesh. In fact, among the major commodities in the consumption basket, the price of rice increased at the fastest rate. This position, however, was completely reversed in the postmodern-technology period, when the prices of rice increased at the same rate as the general rate of inflation in the country.[38] Some of the commodities, such as pulses, beef, and fish, which experienced slower rates of increase in prices than did rice during the earlier period, had price increases at 10 to 50 percent higher rates than rice during the later period. Only for oil, gur (raw sugar), and potato did prices continue to increase at a slower rate. The lower prices for oil and gur may have been maintained by the government by importing substitute commodities, soybean oil,

Table 11—Changes in food and nonfood consumer prices before and after introduction of modern technology

	1950-71			1971-85		
Commodity	Rate of Increase	Standard Error of Estimate	Instability Index	Rate of Increase	Standard Error of Estimate	Instability Index
	(percent/year)		(percent)	(percent/year)		(percent)
Food						
Rice	5.42	0.47	12.9	10.98	0.76	9.0
Pulses	3.89	0.47	12.8	12.16	1.47	14.5
Potato	1.05	0.47	12.2	5.56	1.40	15.8
Gur (raw sugar)	3.51	0.59	17.0	8.99	1.24	14.1
Fish	2.32	0.58	15.8	16.56	1.93	13.6
Beef	3.86	0.27	7.6	16.17	2.51	16.9
Oil	3.43	0.55	15.5	8.89	0.82	9.6
Nonfood						
Firewood	4.98	0.49	14.0	10.98	0.68	9.0
Textiles	1.52	0.58	13.8	9.21	0.66	5.7
Consumer price index	2.95	0.20	5.5	10.99	0.59	6.8

Source: Estimated by fitting semilogarithmic trend lines on time series.

Notes: The retail prices are reported for major urban centers in Dhaka, Chittagong, Khulna, Rajshahi, Sylhet, and Rangpur. The figures in the table are based on the series for Dhaka. The consumer prices are for laborers in the industrial city of Narayangong. The year 1974/75, when famine conditions prevailed in the country, was excluded in estimating trends for the later period.

---

[38] Since rice is a major commodity in the consumption basket, it may be argued that the movement in the cost-of-living index is mainly determined by the rice prices. According to a 1983-84 survey, rice accounted for 32 percent of the national consumption expenditure, so the rice price index and the CPI may not necessarily increase at the same rate. See Bangladesh, Bureau of Statistics, "Report of the Bangladesh Household Expenditure Survey, 1983-84," Ministry of Planning, Dhaka, 1987 (mimeographed).

and sugar and by distributing them to urban consumers through the rationing system, and also by controlling the price of sugar produced in government-owned mills. Potato is the only noncereal food for which the long-run growth in production has been faster than for cereals. The growth rate is estimated at 8.2 percent for 1950-84 and 3.5 percent for 1971-85.

A general problem with agricultural prices in Bangladesh is that they are very unstable. The new crop varieties are less dependent on weather than the traditional ones, as the land on which they are grown generally has access to irrigation facilities. So with a large proportion of cereal production coming from the new varieties, the weather-induced fluctuations in production and prices are expected to be reduced.[39] Table 11 also presents a measure of the instability of consumer prices for the periods before and after introduction of the new technology. Following Cuddy and Della Valle,[40] the instability index is derived as follows:

$$I = CV/(1 - \bar{R}^2),$$

where I is the index (percent), CV is the coefficient of variation (standard deviation as a percentage of arithmetic mean), and $\bar{R}^2$ is the adjusted coefficient of determination of the semilog trend function. It will be noted from the estimates that although the rate of inflation has increased by over three times in the postmodern-technology period, the instability index has not changed much. In general the prices are more unstable for noncereal food crops than for cereals. This has been the experience particularly in the postmodern-technology period, when prices of important food crops such as potato and pulses have been more unstable than they were during the earlier period. For rice, in which the technological progress has taken place, the degree of instability has been reduced; the index went down from about 13 percent for 1950-71 to 9 percent for 1972-85.

The slowing of the increase in real prices of rice, and its greater stability in the postmodern-technology period, may not be entirely due to technological progress. Changes in the government's monetary and fiscal policy can influence these variables. More important, the government has followed a price-intervention policy for rice, declaring support prices and participating in markets through procurement after harvests, and distributing cereals directly to consumers through various channels. The effect of technological progress can only be worked out after dissociating the effect of these other factors, which in itself is an important topic of research and has not been pursued in this study.

Conclusions

In Bangladesh, agricultural growth is constrained by limited availability of land. The amount of cultivated land has not increased since the early 1950s. At present the wasteland that can be reclaimed for cultivation is only about 2 percent of total land. But Bangladesh has vast water resources that can be developed for adoption of modern rice technology to increase foodgrain production. In fact, the country has maintained the food-population balance since its independence in 1971 mainly through technological progress. About one-fifth of cultivated land has been brought under modern irrigation, mostly through public investment. This, together with improved flood control and drainage, has made possible an expansion of MVs to about one-third of the sown area under cereals and an increase in fertilizer consumption from 4.5 to 18.2 kilograms of nutrients per acre during 1971-85. The growth of cereal production has accelerated from 2.6 percent a year during 1950-71 to 3.4 percent during 1971-85, mostly due to acceleration in the growth of crop yields. The productivity growth may have been one of the factors that has helped to keep rice prices low. The retail price of rice, which increased at a rate about 80 percent faster than the cost-of-living index during 1950-71, has moved at par with the general rate of inflation during 1971-85. There is still vast potential for further diffusion of the new technology, whose rate of exploitation may depend on the government's undertaking appropriate policies.

---

[39] In India, instability in cereal production increased greatly in the post-new technology period. Hazell, however, shows that about 82 percent of the increased variation can be attributed to increases in the covariances of production between crops grown in the same state and in different states—a development that cannot be blamed on improved technologies. Only 6 percent of the variances of total cereal production was attributed to variances of individual crop yields measured at the state level. See Peter B. R. Hazell, *Instability in Indian Foodgrain Production*, Research Report 30 (Washington, D.C.: International Food Policy Research Institute, 1982).

[40] J. D. A. Cuddy and P. A. Della Valle, "Measuring the Instability of Time Series Data," *Oxford Bulletin of Economics and Statistics* 40 (February 1978): 79-85.

4

NATURE OF ALTERNATIVE RICE TECHNOLOGIES

The term "technology" is generally used to mean the application of knowledge to produce output through optimum use of combined inputs. The new technology would thus mean a change in the combination of inputs and in their amounts and methods of application. It is important to understand the nature of these changes, because in underdeveloped agriculture, where endowments and real costs of resources vary across farms, the suitability and acceptance of the new technology depend on these changes.[41]

This chapter documents in detail the characteristics of the alternative crop technologies currently in use in Bangladesh and their implications for cost of production, capital requirements, profitability of cultivation, and returns to family resources. The information is drawn mainly from the farm household survey conducted by the International Fertilizer Development Center (IFDC) from aman 1979 through boro 1982 seasons[42] and is supplemented by the information collected by the Bangladesh Institute of Development Studies/International Food Policy Research Institute (BIDS/IFPRI) survey.[43] The IFDC survey is the largest household survey ever conducted in Bangladesh, covering 2,400 randomly selected households from 16 out of 21 Bangladesh (old) districts. The input-output information on crops was collected for about 10,000 sample plots belonging to the selected households. Since the farmers do not keep any records of their operations, the input-use information collected at the plot level tends to be more reliable than those collected at the farm level. The findings of this study are expected to be representative for the country as a whole, and the degree of accuracy is as much as can be obtained by asking questions of the farmers.

As noted earlier, technological progress in Bangladesh is mainly confined to production of rice and wheat. Wheat was an unimportant crop even up to the mid-1970s, but a rapid increase in wheat area since 1975/76 has turned it into the third major crop after rice and jute. Wheat now occupies about 5 percent of total cropped land, most of it under MVs. The scope for further expansion is limited, however, because the soil and the duration of the winter season in Bangladesh are not very suitable for production of wheat. Rice occupies nearly four-fifths of the sown area in the country and is grown in three seasons. The monsoon rice, aman, harvested from November to January, accounts for about 46 percent of cropped land and 58 percent of rice land. About one-fourth of aman land is broadcast-seeded (deep-water variety), sown in March when the land is dry and harvested in November and December when the water recedes. On this type of land the depth of flooding prevents raising any other crop during the monsoon season. On the remaining aman land (medium-low and medium-high elevations) the crop is transplanted, and the MVs have spread to about one-fourth of the area. The early monsoon rice, aus, harvested in July and August, consists mostly of broadcast varieties sown in March-April on either very low or very high land. In some areas transplanted rain-fed aus varieties are also grown.[44] This crop traditionally competes with jute and now accounts for about one-fourth of the total sown area in the country. MVs have spread to about one-sixth of the aus land and have tended to remain at that amount since the late 1970s. Aus MVs are mostly transplanted, but in some areas broadcast MVs are also grown. The remaining one-sixth of rice land is under boro, which is grown under irrigation, transplanted during December-February, and harvested in April-June. The major impact of the new technology has been on this boro rice crop. The cropped area increased from 1.56 million acres in the late 1960s to about 3.89 million acres by 1984/85, facilitated by expansion of modern irrigation. Nearly four-fifths of the area under this crop is now under MVs. The traditional boro is grown on extremely low-lying land that is unsuitable for growing any crop during the monsoon season because of severe flooding. Boro MVs are grown on relatively high land. Since boro and aus seasons overlap, boro MVs compete with aus and jute, whose cropped area has declined steadily in recent years, and there is further possibility of substituting boro MVs for aus crops. The exclusive focus on alternative rice technologies in this chapter is dictated by the importance of rice and the great potential for expansion of the area under MVs.

---

[41] Pears, *Seeds of Plenty.*

[42] International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations.*

[43] BIDS/IFPRI, *Development Impact.*

[44] See Noel P. Magor, *Potential in Rainfed Transplanted Rice Production in North-East Bangladesh* (Dhaka: Bangladesh Rice Research Institute, 1984), p. 32.

Amount and Fluctuation of Crop Yield

Bangladesh has little scope for increasing the supply of land (Chapter 2). Even an individual farmer who has the means to accumulate more land finds it difficult to do so, because in the absence of adequate nonagricultural job opportunities, rural people tend to cling to their holdings and the market for land tends to be thin. So, for both the nation and the individual farmer, the only scope for increasing production is through increased cropping intensity or increased crop yield. A new crop variety that has intrinsic capacity to produce more per unit of land would thus be widely accepted. It would provide the means to increase production from the limited land base through reallocation of land from traditional to new varieties.

Table 12 presents the findings of the two surveys on yield rates (output per unit of land) for the alternative crop varieties and compares them with the official statistics for the entire country. Since yields vary considerably from year to year, the figures are presented as averages for a number of years, which should give a relatively normal picture. The IFDC survey estimated the yield for three years, from 1979/80 to 1981/82, and the BIDS/IFPRI survey for two years, 1981 and 1982. The survey estimates are very close to the official statistics, which support the representativeness of the surveys. The MVs produce more output per unit of land than do the traditional varieties in all three seasons: about one and a half times higher during the aus season, three-fourths higher during the boro season, and one-half higher during the aman season. On average, the yield of the new varieties is about 100-120 percent higher than the yield of traditional ones. Diffusion of the new technology thus contributes to a substantial increase in rice production from the limited land.

A large majority of farmers in Bangladesh operate around or below the subsistence level, so they may respond not only to the average yield but also to the fluctuations in yield, thus making investment in agricultural inputs a risky venture. Being risk-averse, a farmer may be willing to sacrifice a substantial amount of expected income—as indicated by higher mean value of output in the MVs—in exchange for a low probability of falling below the subsistence level. The new crop varieties are less dependent on weather than are traditional ones, since the land has access to irrigation facilities, and during the monsoon season they are generally grown on higher land, which is less

Table 12—Estimates of crop yield for traditional and modern varieties of rice

		IFDC Survey	BIDS/IFPRI Survey	Government Statistics
Season/Variety	Weight[a]	Annual Average, 1980-82	Annual Average, 1981 and 1982	Annual Average, 1982-85
			(tons of paddy/acre)	
Aus (early monsoon)				
Traditional	0.180	0.53	0.48	0.50
Modern	0.037	1.28	1.31	1.32
Aman (monsoon)				
Traditional, broadcast	0.103	0.62	0.69	0.61
Traditional, transplanted	0.265	0.77	0.70	0.75
Modern, transplanted	0.089	1.11	1.16	1.17
Boro (dry winter)				
Traditional	0.026	0.79	1.01	0.93
Modern	0.094	1.51	1.51	1.66
All seasons[b]				
Traditional	0.574	0.67	0.65	0.65
Modern	0.220	1.31	1.33	1.41
			(percent)	
Difference in modern over traditional	. . .	96	105	117

Sources: International Fertilizer Development Center survey and Bangladesh Institute of Development Studies/ International Food Policy Research Institute field survey. Government statistics are based on data from Bangladesh, Bureau of Statistics, *Monthly Statistical Bulletin of Bangladesh,* various issues.

[a] The area under the variety as a proportion of the total cropped area during 1985 for the country as a whole.

[b] Weighted averages.

susceptible to floods. So the weather-induced fluctuation in production is expected to be low for the new varieties. However, they may be more susceptible to pest attacks, and the risk of crop damage on that account is expected to be higher. Also, for rain-fed MVs (for example, aman MVs) water stress may reduce the yield more than in the case of a local variety.[45]

The estimates of variation in crop yields could not be obtained, as primary information from the IFDC survey was inaccessible. The estimates obtained from the plot (1981) and farm (1982) data collected by the BIDS/IFPRI survey are presented in Table 13. The estimates of variation are expected to be lower at the farm level than at the plot level, as the fluctuation is reduced by summing over the data for a number of plots that the farm operates. In 1981, for which the estimates are obtained from the plot data, the standard deviation of yield as a percent of the arithmetic mean is found to vary between 32 and 78 percent.[46] But the magnitude of variation is, in general, lower for the MVs. For MV boro and aman it is about 48 percent, and for aus, 32 percent, compared with 69 percent for traditional aman and 78 for traditional aus. For 1982 also, the magnitude of variation is lower in MVs for the aus and aman seasons and is

---

[45] Magor found that a substantial reduction in rainfall in 1981 over 1980 reduced the yield of modern aman varieties by 30 percent, while the reduction in yield of local varieties was 25 percent. See Magor, *Rainfed Transplanted Rice Production,* p. 32.

[46] Cropping system research in an upazila in Sylhet District found that for the aman crop, 62 percent of the yield variation in 1981 was attributable to transplanting date and water stress. The yield loss per water-stress day was estimated at 75 kilograms per hectare for MVs, compared with 48 kilograms per hectare for a local variety. See Magor, *Rainfed Transplanted Rice Production,* p. 2.

Table 13—Variation in yield for traditional and modern varieties of rice, 1981 and 1982

Season/Variety	1981 Plot Data Number of Plots	Mean Yield	Standard Deviation	Coefficient of Variation	1982 Farm Data Number of Farms	Mean Yield	Standard Deviation	Coefficient of Variation
		(metric tons/acre)		(percent)		(metric tons/acre)		(percent)
Aus								
Traditional, broadcast	584	0.53	0.41	78	152	0.45	0.22	48
Modern, transplanted	281	1.26	0.40	32	86	1.38	0.26	19
Aman								
Traditional, broadcast	379	0.73	0.40	55	144	0.65	0.29	45
Traditional, transplanted	789	0.69	0.48	69	179	0.73	0.50	69
Modern, transplanted	634	1.05	0.51	49	159	1.26	0.77	61
Boro								
Traditional, transplanted	231	1.09	0.69	63	94	0.93	0.33	35
Modern, transplanted	765	1.38	0.66	48	204	1.62	0.65	40

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

similar for the boro season. The boro crop was severely affected by hailstorms in April 1982 in two of the villages where MV boro is a major crop.

For 1982, information was also collected from farmers about the extent of crop damage from natural factors. During that year the aus crops were affected by drought in the villages in Kushtia and Jessore, the aman crops were affected by a flash flood in two villages in Comilla, and the boro crops were affected by hailstorms in two villages in Dhaka and one village in Comilla. Each farmer was asked to report the percentage by which the actual yield was lower than the expected yield, given the application of inputs. The response is subjective, but comparison of the figures for traditional and modern varieties would indicate the direction of change. The findings also show a high degree of crop damage, but it is lower for MVs than for traditional varieties of aus and aman (Table 14). For the boro season, however, the damage is reported to be lower for traditional varieties.

Table 14—Farmers' perception of extent of crop damage, 1982

Season	Traditional Variety Arithmetic Mean	Standard Error	Modern Variety Arithmetic Mean	Standard Error
		(percent of expected yield)		
Aus	45	2.2	32	2.6
Aman	38	2.0	33	2.1
Boro	21	2.6	28	2.0

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Use of Inputs

Family and Hired Labor

The estimates of labor input used per acre of land in operation under different technologies, as obtained from the IFDC survey, are presented in Table 15. The survey collected this information at the plot level for all seasons from aman 1979 to boro 1982. The figures in the table are averages for the three years' estimates. The following features emerge from the table.

Farmers use more labor per unit of land in MVs than in traditional varieties in all three seasons. The increase is about 41 percent for the aus season, 38 percent for the aman season, and 6 percent for the boro season. For all three seasons together, labor use per acre is about 47 percent higher under the MVs.[47] The diffusion of the new technology will thus create more employment from the limited land base through reallocation of land from traditional to modern varieties.

The new varieties, however, economize on labor needed to produce a given amount of output. The amount of labor used to produce a ton of paddy was about 57 eight-hour days for the new varieties, compared with 85 days for the traditional crops. Thus unit cost of production on account of labor was considerably less.

Only a small part of the increase in employment under the new varieties is due to harvesting and threshing of the additional yield. The employment increase is mainly

Table 15—Labor input in rice cultivation for traditional and modern varieties, 1980-82 averages

Season/Variety	Land Preparation	Sowing and Transplanting	Weeding and Other Intercultural Operations	Harvesting and Threshing	All Operations
			(8-hour days/acre of cropped land)		
Aus					
Traditional	14	2	19	21	56
Modern	15	13	23	28	79
Aman					
Traditional, broadcast	11	1	15	25	52
Traditional, transplanted	13	13	7	20	53
Modern, transplanted	15	15	17	26	73
Boro					
Traditional	13	17	25	28	83
Modern	16	17	26	29	88
All seasons					
Traditional	13	7	13	22	55
Modern	15	16	22	28	81
Increase in modern over traditional	2	9	9	6	26

Sources: Compiled from International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1979/80* (Muscle Shoals, Ala.: IFDC, 1982); and International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1981/82* (Muscle Shoals, Ala.: IFDC, 1984).

---

[47] Ahmed estimated from a survey of 459 farms in three villages during 1975/76 that, compared with traditional varieties, the labor input per unit of land in the cultivation of modern varieties was 28 percent higher during the aman season and 50 percent higher during the boro season. See Iftikhar Ahmed, "Technological Change and Labor Utilization in Rice Cultivation: Bangladesh," *The Bangladesh Development Studies* 6 (No. 3, 1977): 359-366.

due to the shift from direct seeding to transplanting of seedlings. For all new varieties, seedlings are grown on a separate seed bed and then transplanted to the main fields. On the other hand, inadequate rain and moisture in the soil during the premonsoon season does not permit transplanting of seedlings for the aus crop, so the seeds are broadcast on the main field, which does not require much labor. For traditional aman varieties the seedlings are transplanted, but mostly in a random manner, while new varieties are mostly transplanted in lines, thus requiring more labor than does random transplanting. The intensive intercultural operations such as weeding, irrigation, and fertilizer use also generate more demand for labor in the cultivation of MVs. The use of labor in land preparation is only marginally higher. Table 15 shows that MVs used 26 additional days of labor per acre, of which 35 percent was generated during sowing and transplanting, 35 percent during weeding and other intercultural operations, 23 percent during harvesting and threshing, and only 7 percent during land preparation.

Transplanting and harvesting are busy agricultural operations for which most farm households hire labor, although they may have surplus labor in the family during other times of the year. By raising labor requirements during these operations, MVs would also increase the demand for hired labor. The IFDC survey did not collect information on the use of hired labor. The estimates obtained from the BIDS/IFPRI survey are presented in Table 16. Nearly two-fifths of the total labor used in rice cultivation came from hired workers, and the proportion was almost the same under the traditional and modern varieties. The new technology thus appears to be neutral in the use of these two types of labor. During the boro and aus seasons, however, MVs use proportionately more hired labor than family labor. The agricultural operations for these two seasons take place from January to June, a traditionally slack period of agricultural activity. Diffusion of the new technology during these seasons would thus reduce the seasonality of underemployment, particularly for the landless who provide hired labor. It will be noted from Table 16 that the additional employment per unit of land generated by

Table 16—Use of hired labor under traditional and modern varieties of rice, 1982

Season/Variety	Hired Labor	Family Labor	Hired Labor as Share of Total Labor
	(8-hour days/acre)		(percent)
Aus			
Traditional	16	40	29
Modern	33	47	41
Aman			
Traditional, broadcast	20	32	38
Traditional, transplanted	22	32	41
Modern, transplanted	30	43	41
Boro			
Traditional	20	62	24
Modern	30	58	34
All seasons			
Traditional	20	36	36
Modern	30	50	38
		(percent)	
Difference in modern over traditional	50	39	6

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

MVs is proportionately more (50 percent) for hired labor than for family labor (39 percent). Thus, poor households who supply hired labor also benefit from technological progress. (See also Chapter 7.)

Animal and Mechanical Power

Bullocks and cows are widely used in Bangladesh to perform heavy agricultural operations such as plowing and leveling land, transporting harvests from the field to the yard of the homestead, and threshing the crop. The animals are used in pairs. The extent of animal power used in the cultivation of different varieties of rice, as estimated by the IFDC survey, is shown in Table 17. The figures are averages for 1979/80-1981/82. For land preparation, use of animal power is higher for transplanted varieties than for broadcast ones, but for harvesting and threshing no systematic pattern is observed. The average use under traditional crop varieties is about 128 hours per acre for a pair of animals. On the basis of an eight-hour working day, employment for a pair of animals comes to about 16 days per acre of land, which is less than one-third of the use of human labor (56 days).

The modern rice varieties generate more demand for animal power due to the practice of transplanting seedlings and the need to transport additional harvest. The extent of increase is found at 15 percent, about a third of the additional demand for human labor. The animal power used per ton of output is 105 pair-hours for MVs, compared with 196 hours for traditional varieties.

In Bangladesh, the market for animal labor is very thin, partly because of the highly seasonal pattern in demand for animal services. The BIDS/IFPRI survey collected information on cultivation expenses for hired animals during the 1982 crop seasons. Only

Table 17—Use of animal and mechanical power for traditional and modern varieties, 1979/80-1981/82 averages

	Animal Power			Mechanical Power			
Season/Variety	Land Preparation	Harvesting and Threshing	Total	Land Preparation	Irrigation	Threshing	Total
	(hours/pair/acre)			(hours/acre)			
Aus							
Traditional	114	24	138	0	0	6	6
Modern	123	26	149	0	7	9	16
Aman							
Traditional, broadcast	89	36	125	0	0	8	8
Traditional, transplanted	106	14	120	0	0	9	9
Modern, transplanted	115	24	139	0	1	9	10
Boro							
Traditional	102	36	138	0	13	4	17
Modern	125	29	154	0	30	9	39
All seasons							
Traditional	105	22	127	0	1	7	8
Modern	121	26	147	0	15	9	24
	(percent)						
Difference in modern over traditional	15	18	15	. . .	large	29	200

Sources: Compiled from International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1979/80* (Muscle Shoals, Ala.: IFDC, 1982); and International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1981/82* (Muscle Shoals, Ala.: IFDC, 1984).

one-fourth of the farmers reported use of hired animals. The average use was equivalent to about 11 pair-days for those hiring animals, and only 3 days for all farms. The practice of animal hiring was more prevalent among very small farmers, presumably because they cannot afford to invest in a pair of animals and bear the maintenance cost. Some large landowners, whose main occupation was nonagriculture, also hired animal power. Owing to the thinness of the market, most of the households that are engaged full time in farming have to keep at least a pair of draft animals, which remains substantially underutilized. Thus the animals are fixed costs, and the cost per unit of output on this account can be reduced by increasing the rate of utilization. The diffusion of modern technology allows more intensive use of animals, since an additional crop is grown on the same piece of land each year.

In many parts of South Asia, diffusion of the new technology followed substitution of machines for animal and human labor. This change is often mentioned as an important factor behind the negative distribution effect of the new technology, although the effect of mechanization on labor use remains controversial.[48] In Bangladesh, mechanization of agricultural operations, except for irrigation, is rarely visible. In some parts of the country a few farmers use small mechanical threshers (mostly in the Comilla, Noakhali, and Chittagong belt), and power tillers (mainly in the Dhaka region for potato cultivation). The 1977 agricultural census noted that among 6.3 million farm holdings, only 35,000 used tractors and 12,000 used power tillers at some time.[49] Only 0.66 percent of farmers reported mechanical cultivation, and the area cultivated was only 0.38 percent.

Information on the use of mechanical power in alternative rice technologies, as estimated by the IFDC survey, is reported in Table 17. Mechanical power is used only for irrigation and threshing. For traditional varieties, mechanical power was used for only eight hours per acre—about 3 percent of the use of animal power. Under MVs, the use is about three times more, but most of the increase is due to power used for irrigation. For threshing, the use is only about one-fifth higher. For land preparation, mechanization has yet to be introduced, even for the cultivation of MVs.

Chemical Fertilizer and Manure

The use of chemical fertilizers is now widespread. The BIDS/IFPRI survey found that nearly 87 percent of farmers used fertilizers, and in irrigated villages almost all farmers used them. Only in 4 out of 16 villages studied was the diffusion limited to less than two-thirds of the farmers. Three of the villages are located in the coastal district of Khulna, which has saline soil, and most of the land is single-cropped with local transplanted aman. The other village is located on the Brahmaputra active flood plain, where most of the land is sown with deep-water broadcast aman.

Many of the fertilizer-using farmers, however, did not apply fertilizer on all plots. The application depends on the type of crop, and whether the plot has previously been treated with fertilizer. The farmers argue that once they apply fertilizer on a plot (for example, to grow the highly fertilizer-responsive MVs), they will have to continue using fertilizer on the same plot even for growing a local variety with low fertilizer response—otherwise the yield will be less than normal. The IFDC survey found that during 1981/82 nearly 45 percent of the land was not treated with fertilizer.

---

[48] For a recent survey of the literature on the labor-displacing effects of agricultural mechanization, see Michael Lipton, *Modern Varieties, International Agricultural Research, and the Poor,* CGIAR Study Paper 2 (Washington, D.C.: World Bank, 1985), pp. 64-70.

[49] Bangladesh, Bureau of Statistics, *The Statistical Yearbook of Bangladesh, 1984-85* (Dhaka: Ministry of Planning, 1985), p. 332.

The findings of the two surveys on the extent of fertilizer use under alternative rice technologies are presented in Table 18. The figures indicate a clear dualism in fertilizer application. Less than one-fifth of the land under deep-water aman and traditional boro is treated with fertilizer. These crops are grown on deep-flooded land where local varieties are less fertilizer-responsive and fertilizer use is less effective. Even on flood-free land, only about 50 percent of the plots are treated with fertilizer if they are sown with local varieties, but more than 90 percent are treated if they are sown with MVs. Fertilizer use on aus and boro season MVs is about six times higher than on the substitute traditional variety, and on aman season MVs the use is about three times higher. On transplanted MVs, use of fertilizers has reached a high level—over 113 kilograms of materials per acre of land. The higher yield of MVs is thus achieved by substantially higher use of chemical fertilizer per unit of land.

To increase soil fertility, Bangladesh farmers also use manures, so a pertinent question is whether intensive fertilizer application on MVs has led to the substitution of chemical fertilizers for manures. The BIDS/IFPRI survey found that nearly two-thirds of the farmers applied farmyard manure, while the IFDC survey found that nearly one-third of the plots were treated with manure. The application of manure was more common in traditional varieties. The findings of the two surveys, however, do not agree on the magnitude of application of manure (Table 18). The IFDC survey showed that use of manure was about [illegible] percent lower for MVs, while the BIDS/IFPRI survey indicated that farmers used almost twice as much on MVs as on traditional varieties.

Table 18—Use of chemical fertilizers and manure for traditional and modern varieties, 1980-82 averages

Season/Variety	Share of Plots Treated (IFDC Survey)		Use per Acre (IFDC Survey)		Use per Acre (BIDS/IFPRI Survey)	
	Fertilizer	Manure	Fertilizer[a]	Manure	Fertilizer[a]	Manure
	(percent)		(kilograms)	(metric tons)	(kilograms)	(metric tons)
Aus						
Traditional, broadcast	45	61	19	1.81	19	1.60
Modern, broadcast[b]	74	66	41	1.93	[c]	[c]
Modern, transplanted	98	29	114	0.61	96	0.89
Aman						
Traditional, broadcast	18	15	7	0.15	5	0.59
Traditional, transplanted	54	24	22	0.25	18	0.10
Modern, transplanted	84	9	68	0.17	84	0.23
Boro						
Traditional, transplanted	12	3	9	0.06	1	0.00
Modern, transplanted	96	34	117	0.62	130	2.22
All seasons						
Traditional	43	33	18	0.71	15	0.65
Modern	91	25	94	0.49	106	1.42

Sources: Compiled from International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1979/80* (Muscle Shoals, Ala.: IFDC, 1982); International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1981/82* (Muscle Shoals, Ala.: IFDC, 1984); and data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] The figures for fertilizer are in weights of different kinds of materials (urea, phosphate, and potash). The nutrient content may be obtained by multiplying the figures by 0.46.

[b] According to the International Fertilizer Development Center survey, about one-fourth of the MV aus area was broadcast-seeded. Information on this is not available for the country as a whole.

[c] In the Bangladesh Institute of Development Studies/International Food Policy Research Institute survey area, modern broadcast aus variety was not grown.

Irrigation and Pesticides

According to the IFDC survey, irrigation was rarely practiced in the cultivation of local aus and aman, but about 65 percent of the plots under traditional boro and 89 percent of the plots under modern boro were irrigated (see Table 19). During the aman season, MVs are grown basically under rain-fed conditions. The intensity of irrigation, as measured by the average number of times of irrigation, is also highest in the cultivation of MVs of boro.

The market for irrigation is imperfect, and the cost of irrigation per unit of land varies widely, depending on the source of irrigation and on the type of ownership of irrigation equipment. Irrigation was provided free of cost to farmers in 2 of the 16 villages in the BIDS/IFPRI survey, as they happened to be under the Ganges-Kobtak project area of the Bangladesh Water Development Board. Two of the villages used low-lift pumps, rented to farmers' cooperatives by the Bangladesh Agricultural Development Corporation. In these villages the water charge paid by farmers varied from Tk 230 to Tk 320 per acre. In three villages where irrigation has been practiced since the late 1960s under the auspices of Comilla-type cooperatives, a combination of low-lift pumps, shallow tubewells, and deep tubewells has been used, and the water charge came to about Tk 650 per acre. In another three villages, irrigation was recently introduced by private shallow tubewell owners, who sold water to owners of adjoining plots at a charge varying from Tk 1,400 to Tk 1,800 per acre. Thus the water charge observed at the farm level in no way measures the irrigation input. The average water charge in the cultivation of boro MVs comes to about Tk 690 per acre for the sample as a whole—about one-eighth of the gross value of output.

Pesticides are rarely used on local varieties, but some use in MVs was noted (Table 19). The increase in cost on this account is only marginal. The highest level of use is on MVs grown during the aus and boro seasons. For these crops the cost on account of pesticides was reported at Tk 90 per acre—only 1.5 percent of the gross value of output.

Table 19—Use of irrigation and pesticides under traditional and modern varieties of rice, 1980-82 averages

Season/Variety	Share of Plots Irrigated	Mean Number of Times Irrigated	Share of Plots Treated with Pesticides	Average Use of Pesticides
	(percent)	(average for plots)	(percent)	(kilograms/ acre)
Aus				
Traditional, broadcast	0	0.0	3	. . .
Modern, broadcast	3	. . .	9	0.12
Modern, transplanted	61	5.4	19	0.25
Aman				
Traditional, broadcast	0	0.0	0	0.00
Traditional, transplanted	5	0.1	. . .	. . .
Modern, transplanted	14	0.8	17	0.12
Boro				
Traditional	65	4.4	3	. . .
Modern	89	7.4	50	0.79

Sources: Compiled from International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1979/80* (Muscle Shoals, Ala.: IFDC, 1982); and International Fertilizer Development Center, *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1981/82* (Muscle Shoals, Ala.: IFDC, 1984).

Seeds

The amount of seed used per unit of land depends on whether the seed is broadcast or a separate seedbed is prepared to grow seedlings that are then transplanted to the main field. According to the Bangladesh Bureau of Statistics, the normal seed requirement for broadcast varieties is 32-37 kilograms per acre, while for transplanted varieties it is about 8-10 kilograms.[50] The value of seedlings is, however, higher than the cost of seeds used, because of the additional cost of land and labor used in seedbed preparation. For traditional varieties, seeds are generally kept from the harvest, but for MVs a significant proportion of the seed may be purchased from markets or government centers (particularly if the seed is new in the area), hence the cost may be higher.

The cost per unit of land was lower for transplanted varieties than for broadcast ones (see Table 20).

Among transplanted crops, the seed cost per unit of land is found to be higher for MVs by about 16 percent for the aman season and nearly 55 percent for the boro season. For all seasons together, the seed cost per acre is almost the same, but because of higher yield, the cost per unit of output for MVs is only about half of that for traditional varieties (Table 20).

Unit Costs and Profitability of Cultivation

This section estimates the effect of the changes in input-output relationships described above on the costs and profitability of rice cultivation. First, estimates are derived by applying national-level prices on the average input-coefficients for 1980-82 (IFDC survey), except for seed, for which the information is only available for 1982. In order to dissociate the effect of climatic factors, the average crop yield for the last three years (1982-85), as reported in official statistics, is used for estimating the gross returns. Then, BIDS/IFPRI survey data are used to estimate profits for different groups of farms at the farm-specific prices of inputs and output.

Table 20—Cost of seeds for traditional and modern varieties of rice, 1982

Season/Variety	Cost per Acre	Cost as Share of Output
	(Tk)	(percent)
Aus		
Traditional	183	9.8
Modern	130	2.6
Aman		
Traditional, broadcast	175	6.5
Traditional, transplanted	135	4.9
Modern, transplanted	158	3.5
Boro		
Traditional	107	2.7
Modern	165	2.8
All seasons		
Traditional	156	6.3
Modern	156	3.0

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

---

[50] Ibid.

National information on farm prices of inputs is not available, except for wage rates. The IFDC survey estimated that for urea, which accounts for over 70 percent of chemical fertilizers consumed in the country, the farm prices were higher than the officially fixed prices in the range of 2.8-10.7 percent for the eight crop seasons for which information was collected. In calculating fertilizer costs, it is assumed that farmers pay about 10 percent more than the official prices set by the government, the variable for which time series information is available. As mentioned earlier, the unit cost of irrigation varies across locations, depending on the source of water. To standardize the cost, the weighted average water charges paid by irrigators to private owners of shallow tubewells (as found in a recent survey by Quasem)[51] are used as the standard to estimate the irrigation cost for other crops by applying the IFDC survey information on the mean number of times a crop is irrigated. For other time periods, the irrigation cost has been adjusted by the price index of diesel. The farm price of manure is available from the IFDC survey for 1980. Similarly, the cost of seed is available only for 1982 (Table 20). For other time periods, the manure and seed costs are derived by adjusting them by the price index of rice. It is reported in a 1980 survey of six villages in Comilla and Noakhali that the hiring charge for a pair of animals, along with the worker who operates them, is about 2.5 times higher than the wage rate paid to hired workers.[52] On this basis, the cost of a pair of animals is assumed at 1.5 times the wage rate, since the hired worker is included in the input of human labor. The family labor input is imputed by the wage rate of the hired labor.

The cost of mechanical power could not be included due to nonavailability of information on rental charges for machines. In any case, nearly two-thirds of the mechanical power input is on account of irrigation, the costs of which are included in irrigation charges. The unaccounted input is only about eight hours per acre (in threshing), the cost of which would be very low as a proportion of the value of output.

Land is an important fixed asset, but the opportunity cost of the investment in land has not been included in the cost of production. The justification is that land, unlike other fixed assets, does not depreciate in value, particularly in countries where land is scarce. According to the Bangladesh Bureau of Statistics, during 1973-84 the price index of single-cropped, unirrigated land (the type of land not affected by productivity-raising investment) increased at an annual rate of about 17.6 percent, compared with the 11 percent rate of inflation during this period and the 14 percent rate of interest currently paid by commercial banks on fixed deposits. Thus a person investing in land can get a higher return than the interest on money deposited in banks, even if the land is kept fallow. In this sense, use of the land for cultivation does not involve any real cost to its owners. For tenants, however, the rent paid to the landowner is a real cost and has to be included in estimating their profits.

Another cost element that has not been included in the estimates is the rate of interest paid on working capital borrowed from outside. In Bangladesh, farmers borrow for agricultural purposes from various institutional sources, which generally charge 16 percent interest annually. Borrowings from informal sources for extremely short periods are widespread. These informal loans bear high rates of interest (10 percent a month is common) and so may not be used for financing production expenses. Also, information on credit is available at the household level and is difficult to apportion to various crops. The BIDS/IFPRI survey found that the sample farmers borrowed an average of Tk 150 per acre of cropped land from institutional sources during 1982. This amount constituted only one-fourth of total borrowing. The cost has not been included because of the problem of apportioning it to various crops.

---

[51] Md. Abul Quasem, *Impact of the New System of Distribution of Fertilizer and Irrigation Machines in Bangladesh—Survey Findings,* Research Report 62 (Dhaka: Bangladesh Institute of Development Studies, 1987), p. 30.

[52] Bangladesh Unnayan Parishad, *A Socio-Economic Evaluation of the Chandpur II Irrigation Project,* a report prepared for the World Bank (Dhaka: Bangladesh Unnayan Parishad, 1982), app. A, pp. 6-25.

The choice of an appropriate price for output is a problem. Here the growers' price of paddy as reported by the Bangladesh Bureau of Statistics is used. The government also declares, in advance of the harvest, a procurement price for paddy at which the farmers can sell their produce at government-operated purchasing centers. While it is estimated that nearly 40 percent of the rice is marketed, the average procurement of the government in 1980-85 was only about 2 percent of domestic production. Use of the growers' price thus appears more appropriate. Another problem is the quality differences for different varieties of rice. The grain of the rice MVs produced during the aus and boro seasons is coarse and fetches the lowest price in the market. Among traditional varieties, aus and boro are coarse, while aman grains are generally of superior quality and fetch the highest prices. Information provided by the Department of Agricultural Marketing shows that the average price of fine-quality aman rice during 1980-84 was about 22 percent higher than the price of MV rice.[53] For the present calculation, the reported average growers' prices for traditional varieties of aus and boro and MVs of aman have been applied, and prices have been assumed to be 10 percent higher for traditional aman and 10 percent lower for MVs of aus and boro.

Estimates of costs and returns have been made at prices for 1984/85, the most recent year for which price information was available. However, the relative input-output prices underwent considerable change during 1975-85, partly because of the government policy of gradual withdrawal of subsidies from modern inputs such as fertilizers and irrigation, which are used more in the cultivation of MVs. Some of the profitability gains of the new technology may have been eroded by such price changes. In order to see the effect of price changes on profitability, costs and profits have also been estimated at 1975/76 prices.

The estimates of costs and profits at 1984/85 prices are presented in Table 21. The "cash cost" includes the cost of seed, fertilizer, manure, irrigation, pesticides, and hired labor, while the "total cost" also includes the imputed value of family and animal labor. Small farmers and tenants who have surplus family labor and low opportunity cost of employing it elsewhere may give more weight to cash costs in making production decisions than to total cost, which is a more relevant variable for the large farmers who have high opportunity cost of family labor. The cash cost per unit of land also shows the working capital requirement, and the small farmer may be in a more disadvantaged position to supply it than the large farmer, who would have a higher amount of surplus (production over family consumption) and better access to financial institutions. In the cultivation of traditional varieties, the cash cost of production per unit of land is almost the same in the aus and aman seasons, but about three-fourths higher in the boro season because of the requirement for irrigation. Per unit of output, however, the cost is lowest for the aman season crops. In transplanted aman, the cost is about one-fourth lower than for aus (highland) or boro (lowland) varieties.

In the cultivation of MVs, the cash cost per unit of land is about 1.7 times higher than for the traditional varieties—1.9 times for the aus season, 1.1 times for the boro season, and nearly three-fourths for the aman season. The MVs have higher yields, but

---

[53] Bangladesh, "Wholesale Prices of Agricultural and Animal Products in Bangladesh, 1972-85," Department of Agricultural Marketing, Dhaka, 1986 (mimeographed).

Table 21—Costs of production and profits under traditional and modern varieties, at 1984/85 national-level prices

Season/Variety	Cash Costs		Total Costs		Estimated Profit	
	Per Acre	Per Metric Ton	Per Acre	Per Metric Ton	Per Acre	As Share of Costs
			(Tk)			(percent)
Aus						
Traditional	736	1,466	2,524	5,027	−35	−1
Modern	2,121	1,612	4,149	3,153	1,723	42
Aman						
Traditional, broadcast	737	1,205	2,261	3,699	1,071	47
Traditional, transplanted	811	1,089	2,299	3,086	1,764	77
Modern, transplanted	1,406	1,198	3,242	2,761	2,578	80
Boro						
Traditional	1,354	1,454	3,666	3,937	950	26
Modern	2,808	1,696	5,136	3,102	2,253	44
All seasons						
Traditional	799	1,226	2,425	3,720	1,038	43
Modern	2,122	1,510	4,200	2,990	2,296	55
			(percent)			
Difference in modern over traditional	166	23	73	−20	121	12

Source: Estimated from International Fertilizer Development Center survey data.

per unit of output the cash cost is also higher for their cultivation. For all three seasons, the weighted average difference is about 23 percent. The absolute cash cost on account of purchased inputs is Tk 1,513 per ton of paddy for MVs and Tk 1,226 for traditional varieties.

A different conclusion is reached if total cost of production is considered. The cost per unit of land is higher by about three-fourths for the cultivation of MVs than for traditional varieties, but the cost per unit of output is lower by about one-fifth. The absolute cost per ton of paddy is Tk 3,720 (US$124) for traditional varieties and Tk 3,000 (US$100) for MVs. Compared with traditional aus (the main substitute crop), which has the highest unit cost of production (US$168 per ton), the cost of cultivation of MVs is lower by about 40 percent.

Since land is scarce, the farmer is interested in maximizing the net return per unit of land. At the assumed average prices the profit (gross return minus total cost) is negative for cultivation of the traditional aus variety[54] and is substantially lower for all other traditional varieties compared with MVs. For all seasons, the difference in net return per unit of land is Tk 1,250 per acre—about 1.2 times higher for cultivation of MVs than for traditional varieties. Subsistence farmers may be interested in maximizing the net return to the family (gross returns minus cost of purchased inputs). The new technology gives a better return in this respect also. The return to family inputs is estimated at Tk 4,370 per acre for MVs, compared with Tk 2,670 for traditional varieties—an increase of about 64 percent. The family income per day of labor is estimated at Tk 87 for MVs, compared with Tk 75 for local varieties. The wage rate of agricultural labor prevailing in 1984/85 for the country as a whole was Tk 24.

---

[54] The traditional aus is a very low yield crop, and in areas in which it is a major crop, the wage rate is also found to be very low. For the BIDS/IFPRI sample, the wage rate paid for cultivation of local aus is estimated at Tk 12.92 per day, compared with Tk 23.88 in the cultivation of modern-variety boro. If the cost of labor is evaluated at the crop-specific wage rate, the net profit in the cultivation of local aus would also be positive.

Households that consider farming as an investment alternative base their decisions on the rate of return on capital. The estimates of total cost show that the new technology gives scope for investing more capital on a fixed amount of land. The rate of profit, measured as a percentage of total cost, is also found to be higher for MVs, particularly during the aus and boro seasons. For all three seasons, the rate of profit is estimated at 55 percent for the new varieties compared with 43 percent for the traditional ones.

Whether the farmers would consider the rate of profit adequate to maintain a reasonable standard of living is a separate issue. Comparison of the rate of profit in farming with that in nonagricultural activities is not justified, because accumulation of capital in farming is constrained by the amount of land owned, while in nonagriculture profits can be reinvested for further accumulation. Only about 5 percent of households in Bangladesh operate farms larger than 7.5 acres. If a 7.5-acre farm grew one traditional and one modern variety during a year, it would have a profit of about Tk 24,700, which for a six-member household gives a per capita income of Tk 4,110. For 1984/85 the per capita income for the nation was estimated at Tk 3,990, and the poverty-level income at Tk 3,096.[55] Thus, even at this high rate of profit, farming alone does not guarantee an acceptable standard of living for a large-farm family.

The effect of the changes in agricultural prices during 1975-85 on cost and profitability in rice cultivation is shown in Table 22. Owing to the gradual withdrawal of

Table 22—Effect of price changes on costs of production and profits, 1975/76-1984/85

Season/Variety	Costs of Production			Profits		
	1975/76	1984/85[a]	Change	1975/76	1984/85[a]	Change
	(Tk/acre)		(percent)	(Tk/acre)		(percent)
Aus						
Traditional	928	1,104	19	41	−15	large negative
Modern	1,402	1,814	29	883	753	−15
Aman						
Traditional, broadcast	831	989	19	465	468	1
Traditional, transplanted	838	1,005	20	743	771	−4
Modern, transplanted	1,144	1,418	24	1,121	1,128	1
Boro						
Traditional	1,256	1,603	28	540	415	−23
Modern	1,669	2,246	35	1,207	985	−18
Ali seasons[b]						
Traditional	890	1,060	19	437	454	4
Modern	1,423	1,836	29	1,097	1,004	−8
Total	965	1,[illegible]5	32	530	606	14

Source: Estimates are based on crop-level input-output data obtained from the International Fertilizer Development Center survey and on prices of inputs and output in Bangladesh, Bureau of Statistics, *The Statistical Yearbook of Bangladesh*, various issues (Dhaka: Ministry of Planning, various years).

[a] Estimated at 1984/85 prices of inputs and output and then converted at 1975/76 constant prices by using the consumer price index for 1975/76 and 1984/85.

[b] Weighted averages, using the share of crop variety of the total cropped area under rice in Bangladesh for the referenced year.

---

[55] The Bangladesh Bureau of Statistics has recently made estimates of the poverty line income for 1981/82 from the returns of the national household expenditure survey. This figure is based on this estimate, adjusted for changes in the cost-of-living index. For details see Chapter 8 of this study.

subsidies, input prices have increased faster than output prices. The cost of cultivation in real terms increased by about one-third during that period, and the rate of increase was faster for MVs, since they are more fertilizer- and water-intensive. The rate of profit over the investment in working capital declined from about 55 percent in 1975/76 to 48 percent by 1984/85; the rate of decline has been faster for MVs—from about 77 percent to 55 percent during the same period. The profit per unit of the scarce factor, land, has also declined, particularly for aus and boro season crops. But the absolute profit in cultivating MVs remains much higher than that for traditional varieties. In spite of declining profits in individual crop varieties, farmers have increased the profits per unit of land for all crops taken together, through reallocation of land from low- to high-profit crops. The share of MVs in the total sown area under rice doubled from about 14 percent in 1975/76 to 28 percent by 1984/85. The productivity growth as a result of this reallocation of land has ensured farmers about 14 percent higher profits in spite of the adverse movement in relative input-output prices.

The government controls the supply of fertilizer and irrigation, and the operation involves a considerable amount of subsidy. Since these inputs are consumed more in the cultivation of MVs than traditional varieties, a pertinent question is what would happen to the difference in costs and profits if the subsidies were fully withdrawn. As mentioned earlier, through a number of consecutive price increases the fertilizer subsidies had been withdrawn by 1985. The fertilizer price used in the calculation (US$167 per ton) is close to the world price. The cost of irrigation would, however, increase if subsidies were withdrawn. The Master Plan organization estimated that for 1984 the annualized capital cost plus the operation and maintenance for irrigation would come to Tk 1,720 per acre for deep tubewells and Tk 1,530 for large-scale irrigation projects (at economic prices).[56] In the cost calculation a water rate of Tk 1,250 per acre was assumed. Thus, if the subsidies are withdrawn, the irrigation charge to farmers may increase by about 37 percent.[57] At this price the total cost of production would be Tk 3,168 per ton of paddy for MVs, compared with Tk 3,738 for traditional varieties—still about 15 percent lower. The net profit would be Tk 2,050 per acre for MVs, compared with Tk 1,025 for traditional varieties.

The estimates of costs and profits at farm-specific prices, input use, and yield rates obtained from the BIDS/IFPRI survey are shown in Table 23. To estimate total costs, family labor was imputed at the wage rate paid by the household to hired labor. For households that did not hire labor, the average wage rate for the village was used to impute cost. Costs on account of animal labor supplied by the family could not be included, as the survey did not collect information on this variable. Seeds, both household-supplied and purchased, were included in cash costs. The estimates show substantially higher costs of production for cultivation of MVs than for local varieties, but the superiority of MVs is clearly demonstrated in profits and family income per unit of land. Cultivation of MVs yielded Tk 1,570 additional profits per acre of land and Tk 1,835 additional return to family labor and animals. The net income per day of family labor is estimated at Tk 53 for local varieties and Tk 74 for MVs, while hired labor was paid an average wage of Tk 19.5.

---

[56] Cited in Hossain, "Fertilizer Consumption," p. 224.

[57] The actual subsidy on irrigation may in fact be higher than this proportion. A large part of the irrigation subsidy is consumed by owners of irrigation machines, who charge substantially higher prices to water users than the capital and operation costs. For 1982/83 the markup (water charge paid by irrigators over the cost) is estimated at 62 percent for deep tubewells, 34 percent for power pumps, and 10 percent for shallow tubewells. See Osmani and Quasem, "Pricing and Subsidy Policies," p. 166.

Table 23—Costs and profitability at farm-specific prices, production and input use, 1982

Season/Variety	Gross Value of Output	Cash Costs of Production	Total Costs of Production	Returns to Family Labor	Profits
			(Tk/acre)		
Aus					
Traditional	1,618	528	992	1,090	626
Modern	5,395	1,381	1,931	4,014	3,464
Aman					
Traditional, broadcast	2,596	569	1,023	2,027	1,573
Traditional, transplanted	2,737	742	1,118	1,995	1,619
Modern, transplanted	4,854	1,193	1,777	3,661	3,077
Boro					
Traditional	3,800	536	960	3,264	2,840
Modern	5,767	2,103	2,945	3,664	2,822
All seasons					
Traditional	2,511	626	1,050	1,885	1,461
Modern	5,330	1,610	2,299	3,720	3,031
All varieties	3,292	899	1,396	2,393	1,896

Source: Estimated from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey data.

Table 24 shows the estimates of profits for different farm sizes and tenurial groups. For MVs, profits are higher on larger farms, but for traditional varieties no systematic pattern is found. The tenants pay 50 percent of the gross produce as rent for the sharecropped land. After deduction of the rent the profit is very small on the sharecropped land, but is higher for MVs than for local varieties. The net return to tenants' family labor and draft animals was Tk 750 per acre for local varieties and Tk 1,140 for MVs, or about 52 percent higher. The net return per day of tenants' labor is estimated at Tk 21 for local varieties and Tk 23 for MVs—only marginally higher than the average rate of Tk 19.5 for the entire sample. Thus the rented land benefits tenant farmers mainly through reducing underutilization of family labor and animals.

Table 24—Profits and family income at farm-specific prices for different farm sizes and tenurial groups, 1982

	Profits			Return to Family Labor and Animals		
Group of Farmers	Traditional Varieties	Modern Varieties	Difference	Traditional Varieties	Modern Varieties	Difference
	(Tk/acre)		(percent)	(Tk/acre)		(percent)
Landownership group						
Small (less than 2.5 acres)	1,355	2,619	93	1,688	3,747	100
Medium (2.5 to 5.0 acres)	1,539	2,669	73	1,967	3,349	70
Large (5.0 or more acres)	1,448	3,685	155	1,787	4,152	132
Tenurial group						
Owner-cultivator	1,322	3,062	132	1,797	3,682	105
Owner-cum-tenants	1,154	2,049	78	1,578	2,829	79
Owned land	1,069	2,974	85	2,034	3,754	85
Rented land	323	360	12	748	1,140	52

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Comparison of relative gains from adoption of MVs across different groups shows that owner-farmers gain more than tenants, and large farmers gain more than small and medium ones. But the gains of small farmers are also higher than those of medium ones. Thus the gains are not systematically positively related to the size of household landownership.

Conclusions

The rice MVs have opened up an opportunity to increase production substantially from a given amount of land. The yield of MVs on a farmer's field is twice that of the traditional varieties. The fluctuations in yield caused by natural factors are also lower for MVs, indicating that the new technology has reduced the risk of cultivation. Farmers use about 45 percent more labor per unit of land for the cultivation of MVs than for traditional varieties. But per unit of output, use of labor is about 35 percent lower, and use of draft power is about 45 percent lower for MVs. The new crops, however, use substantially more fertilizer, irrigation, and pesticides per unit of output. The cash costs of production per unit of land are about 1.7 times higher, and per ton of output are about one-fifth higher for MVs. The total cost of production per ton of paddy is estimated (at 1984/85 prices) at US$100 for MVs, compared with US$124 for traditional varieties. The profit per acre of land is estimated at Tk 2,300 for MVs, which is about 2.2 times that for traditional varieties (Tk 1,040). The rate of profit over the cost of production is 55 percent for MVs, compared with 43 percent for traditional varieties. The gradual withdrawal of subsidies from fertilizer and irrigation during 1975-85 has reduced the profitability gap, but farmers have increased their profits from cultivation of rice through reallocation of land from traditional to modern varieties, since the absolute profit for MVs is still higher. Even if subsidies were fully withdrawn, the profit per unit of land would still be about twice as much for cultivation of new varieties as for traditional ones, and the unit cost of output would be about 15 percent lower.

5

PRODUCTIVITY AND EFFICIENCY OF RESOURCE USE

The effects of the new technology on productivity of land and labor and on efficiency in their utilization are assessed in this chapter. Land is the most scarce input in Bangladesh. It could be argued that the development of irrigation, which is the most critical input in the modern technology package, could raise the effective supply of land by creating conditions for growth of an extra crop on fallow land during the dry winter season.[58] In order to see whether and to what extent this has happened in Bangladesh, the first section compares the pattern and the intensity of land use in the technologically developed and underdeveloped areas as well as on the irrigated and unirrigated land. This is followed by an analysis of the production function for estimating the factor shares and the marginal productivity of land and labor for traditional and modern technology. The final section applies a profit function model to study the relative economic efficiency of adopters of the new technology and farmers still growing only traditional crops.[59] The analyses in this and the following chapters are based on disaggregated farm and plot data collected by the BIDS/IFPRI survey.[60]

Intensity of Land Use and Cropping Patterns

The effect of technological change on the pattern and intensity of land use can be seen in Tables 25 and 26. The tables are based on information collected at the plot level on the use of the land during the three crop seasons in 1981 in the 16 villages covered by the BIDS/IFPRI survey. The survey enumerated 5,255 plots belonging to 639 sample households (8.2 plots per household). About 68 percent of the plots were owner operated; 13 percent were rented out to others, mostly under sharecropping arrangements; 6 percent were under orchards or bamboo bushes; 2 percent were under ponds; and the remaining 11 percent were under homesteads. Some of the landowners did not know about the use of the plots operated by tenants, so complete information could not be obtained for this type of land. It was also found that the practice of renting out land for only one season was prevalent; the plot rented out for cultivation during the boro season was taken back by some landowners for self-cultivation during the aman season. To avoid problems caused by these complications, the information presented here is based on the data obtained for the owner-operated plots only. The following main points can be noted from the information.

Irrigation has a significant effect on increasing the effective supply of land during the boro season. Only two-fifths of the unirrigated land is cropped during the boro

---

[58] Shigeru Ishikawa, *Economic Development in Asian Perspective* (Tokyo: Kinokuniya, 1967). For Bangladesh this hypothesis has been tested in James K. Boyce, "Water Control and Agricultural Performance in Bangladesh," *The Bangladesh Development Studies* 14 (No. 4, 1986): 1-35.

[59] Lawrence J. Lau and Pan A. Yotopoulos, "Profit, Supply and Factor Demand Functions," *American Journal of Agricultural Economics* 54 (No. 1, 1972): 11-18; and Lau and Yotopoulos, "A Test for Relative Efficiency and an Application to Indian Agriculture," *American Economic Review* 61 (No. 1, 1971): 94-109.

[60] BIDS/IFPRI, *Development Impact.*

Table 25—Pattern and intensity of use of irrigated and unirrigated land, 1981

Season/Crop	Irrigated Land Sown Area	 Share of Cultivated Land	Unirrigated Land Sown Area	 Share of Cultivated Land
	(acres)	(percent)	(acres)	(percent)
Aus	70.84	21.0	198.20	30.4
Local aus	12.82	3.8	148.65	22.8
Modern-variety aus	54.41	16.1	4.25	0.6
Jute	3.60	1.1	45.30	7.0
Aman	227.80	67.6	412.10	63.2
Local broadcast aman	18.23	67.6	119.82	63.2
Local transplanted aman	83.76	24.9	237.27	36.4
Modern-variety aman	125.45	37.2	15.75	2.4
Sugarcane	0.35	0.1	39.25	6.0
Boro	257.50	75.4	251.15	38.6
Local boro	14.75	4.4	44.40	6.8
Modern-variety boro	196.65	58.3	13.55	2.1
Wheat	9.40	2.8	21.17	3.3
Pulses	10.03	3.0	117.00	18.0
Oilseeds	19.80	5.9	21.35	3.3
Vegetables	5.35	1.6	15.20	2.3
Spices	1.50	0.5	14.38	2.2
Other	. . .	. . .	4.10	0.6
Total cropped land	556.15	165.0	861.45	132.2
Total cultivated land	337.10	100.0	651.75	100.0

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.
Note: Parts may not add to totals because of rounding.

season, but with irrigation the intensity of use increases to about three-fourths (Table 25). Part of the increase is at the expense of the overlapping aus season crops, which are grown on 30 percent of the unirrigated land, but on only 21 percent of the irrigated land. MV boro, for example, competes for land with local aus and jute. It is harvested at the beginning of May, when it is too late to broadcast aus and jute seeds on the same land. About 31 percent of the land remains fallow over these two seasons when the land is unirrigated, but the proportion is reduced to only 14 percent with access to irrigation facilities. Irrigation, however, does not change the pattern of land utilization during the aman season, when crops are grown basically under rain-fed conditions. Two-thirds of the cultivated land is cropped during the aman season; one-third remains fallow, presumably owing to excessive flooding. Provision of irrigation facilities does not appreciably change the proportion of aman season fallow land.

The adoption of MVs is facilitated mostly by irrigation. Only 6 percent of the unirrigated land was used to grow MVs during the three seasons. For irrigated land the proportion was about 112 percent, which also indicates that some of the land was used to grow two MV rice crops during the same year. Of the 86 percent of irrigated land cropped during the aus and boro seasons, 75 percent was used for growing MV rice. Only during the aman season was a large proportion of the irrigated land used to grow local paddy.

Irrigation has an adverse effect on diversification of crops. Except for rice and oilseeds, all crops are grown less often on irrigated land than on unirrigated land. Following the development of irrigation facilities, rice varieties replace not only the low-yielding pulses but also the major cash crops, jute and sugarcane. These three

Table 26—Pattern and intensity of land use in technologically developed and underdeveloped villages, 1981

Season/Crop	Developed Villages		Underdeveloped Villages		All Villages	
	Cropped Land	Share of Cultivated Land	Cropped Land	Share of Cultivated Land	Cropped Land	Share of Total Cultivated Land
	(acres)	(percent)	(acres)	(percent)	(acres)	(percent)
Aus	100.78	21.4	168.23	32.5	269.01	27.2
Local aus	29.20	6.2	132.30	25.6	161.50	16.3
Modern-variety aus	51.67	11.0	6.96	1.3	58.63	5.9
Jute	19.91	4.2	28.97	5.6	48.88	5.0
Aman	312.80	66.4	327.05	63.1	639.85	64.7
Local broadcast aman	58.59	12.4	79.46	15.3	138.05	14.0
Local transplanted aman	110.34	23.4	210.72	40.7	321.06	32.5
Modern-variety aman	134.96	28.7	6.22	1.2	141.18	14.3
Sugarcane	8.92	1.9	30.65	5.9	39.57	4.0
Boro	293.44	62.3	215.40	41.6	508.84	51.5
Local boro	39.72	8.4	19.44	3.8	59.16	6.0
Modern-variety boro	184.26	39.1	25.91	5.0	210.17	21.3
Wheat	8.57	1.8	22.03	4.3	30.60	3.1
Pulses	16.62	3.5	110.43	21.3	127.05	12.8
Oilseeds	26.30	5.6	14.85	2.9	41.15	4.2
Vegetables	9.51	2.0	11.04	2.1	20.55	2.1
Spices	6.89	1.5	8.99	1.7	15.88	1.6
Other	1.58	0.3	2.72	0.5	4.30	0.4
Total sown area	707.02	150.1	710.68	137.2	1,417.70	143.4
Total cultivated area	470.95	100.0	517.91	100.0	988.86	100.0

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Note: Parts may not add to totals because of rounding.

crops are grown on about 31 percent of the unirrigated land, but on only about 4 percent of the irrigated land. Owing to the large-scale replacement of noncereal crops by rice, the effect of irrigation on intensity of land use is much less pronounced than its effect on cereal cultivation. The sown area under cereals is about 87 percent of cultivated land for the unirrigated plots; with irrigation the proportion rises to about 153 percent—an increase of over 66 percent. The total cropping intensity is, however, estimated at 165 percent for the irrigated land, compared with 132 percent for unirrigated land—an increase of only 33 percent.

Table 26 compares the patterns of land use in sample villages that are classified into two equal-size groups according to the scale of diffusion of the new agricultural technology (see Chapter 2). MV rice is grown on almost 80 percent of the cultivated land in the developed villages, compared with only 8 percent of the land in underdeveloped villages. For the aus and boro seasons together, the proportion of cultivated land under MV rice in both groups of villages is similar to the proportion of area irrigated, indicating a singular relationship between irrigation and adoption of MV seeds. This supports the findings of strong complementarity between the two inputs reported in Chapter 3 on the basis of regression analysis of district cross-section data. Intensity of land use is estimated at about 150 percent for the technologically developed villages, compared with 137 percent for the underdeveloped villages. Thus a 40 percent increase in irrigation leads to a 13 percent increase in effective supply of land, indicating an elasticity of supply of land to irrigation of 0.33.

Productivity of Land and Labor

A technique frequently used to analyze productivity and efficiency of resource use is the Cobb-Douglas production function. The technical coefficients of production estimated from the function are used in various policy applications. The input coefficients of the function represent production elasticities of the inputs. The sum of the elasticities is used as an indicator of the degree of returns to scale in production. This section uses the farm-level cross-section data for 1982 to estimate production functions for the traditional and modern varieties of rice in order to study the effect of the new technology on productivity of land and labor.

The production function for each crop was fitted in the following form:

$$\text{Ln}Y_i = \text{Ln}\beta_0 + (\beta_1 + \beta_2)\text{Ln}A_i + \beta_2\text{Ln}(N/A)_i + \sum_{j=1}^{15}\lambda_{ij}V_{ij} + V_iD_i, \qquad (1)$$

where Y_i is the value added (Tk) for the ith farm in the cultivation of the crop, as measured by the gross value of output net of the costs on account of seeds, manure, fertilizer, pesticides, and irrigation. The cost of animal labor could not be included owing to nonavailability of data. Ln is the natural logarithm of the variable, A is the amount of land sown under the crop, and N is the total number of labor days (hired plus family labor) used during the production period (from land preparation to threshing). A number of crops were affected by droughts, floods, and hailstorms during the year, and the effect was not uniform across villages or across farms within a village (owing to variations in land elevation). Information was collected from every farmer about the amount of crop damage as a percentage of the harvest expected, given the extent of application of the inputs. This farm variable, D_i, has been used to dissociate the effect of natural calamities. Since the information comes from 16 widely scattered villages in different ecological zones, it is expected that the variation in climate, soil type, and intensity of land use permitted by these agroclimatic factors would contribute to some variation in output, irrespective of the amount of inputs used. Therefore 15 village dummy variables, V_j, have been used to dissociate the effect of the environmental factors. The coefficients β_1 and β_2 are the output elasticity of land and labor, respectively. The coefficient of $\text{Ln}A_i$ gives the sum of the elasticities, which, along with its standard error of estimate, can be used to test the hypothesis about the degree of returns to scale in the specific crop-production activity.

Equation (1) is a modified form of the general Cobb-Douglas production function,

$$\text{Ln}Q_i = \text{Ln}\beta_0 + \sum_{j=1}^{m}\beta_i\text{Ln}X_{ij}, \qquad (2)$$

where for the ith farm, Q is the gross output, and X_j is the amount of the m different inputs used in its production. This particular functional form assumes that the elasticity of substitution between any two inputs is equal to one. Value added is used instead of gross output and is related only to the primary inputs, land and labor, for the following reasons. Seed is an important material input, but it has a technologically fixed relationship with land, which violates the unit elasticity of substitution assumption. The variation in the amount of fertilizer used per unit of land in individual crop varieties is limited to a certain range. Changes in the use of fertilizer are realized more through choice of crop varieties. Animal power is an important input, but it is used along with human labor, which produces strong complementarity rather than substitutability assumed in the production function. Inputs like fertilizer and irrigation are also complements rather than substitutes. Fertilizer, manure, pesticides, and irrigation are not essential for production of local varieties: this is indicated by the small proportion of farmers applying these inputs (see Chapter 4). The log-linear production function is not appropriate if these inputs are used as explanatory variables. Thus deduction of the costs on account of the material inputs from the gross value of production appears more appropriate than using them as separate variables in the Cobb-Douglas production function framework.

Since farm-level cross-section data are used to estimate the function, one expects the amount of land and labor to be highly correlated across farms. This creates the well-known problem of multicollinearity in estimating the parameters of the function. To avoid this problem, the labor input has been measured per unit of land, which breaks the high degree of correlation between land and labor. This produces the modified form of the function as shown in equation (1), in which the coefficient of logarithm of the land variable becomes the sum of the elasticities of land and labor.

The estimates of the parameters of the function obtained from use of the OLS method are reported in Table 27. The following major conclusions can be drawn from the findings.

Crops are significantly affected by damage due to natural factors. The coefficient of damage is statistically significant for all crop varieties. This indicates the prevalence of a high degree of uncertainty in rice cultivation, so the farmer cannot be sure about the productivity of the inputs applied on the land. Thus the rate of application of the inputs may depend not only on the prices but also on the degree of risk aversion of the farmer. The regression coefficient of crop damage is, however, found to be lower for MVs than for traditional varieties in all three seasons.

Table 27—Estimates of Cobb-Douglas production functions for different varieties of rice, 1982

Season/ Variety	Constant	Elasticity[a]		Coefficient of Crop Damage	$\bar{R}^2$	'F' Statistic
		Land	Labor			
Aus						
Local	5.640 (0.980)	0.511 (0.055)	0.555 (0.190)	−1.41 (0.19)	0.82	59.0
Modern	7.364 (0.852)	0.701 (0.062)	0.338 (0.190)	−0.86 (0.31)	0.89	98.6
Aman						
Local	6.110 (0.474)	0.570 (0.060)	0.490 (0.120)	−0.86 (0.12)	0.82	46.9
Modern	7.701 (0.417)	0.636 (0.053)	0.374 (0.100)	−0.54 (0.18)	0.83	66.9
Boro						
Local[b]	7.280 (0.298)	0.787 (0.028)	0.296 (0.080)	−1.13 (0.14)	0.96	720.0
Modern	7.196 (0.262)	0.613 (0.023)	0.371 (0.063)	−0.69 (0.08)	0.93	669.4

Notes: Figures in parentheses are standard errors of the estimated coefficients. The regression coefficients of village dummies have not been reported.

[a] The standard error of estimate is for the sum of the elasticity of land and labor.

[b] Local boro is grown in only one ecological zone. Hence the village dummies have not been used.

The sum of the output elasticity (factor share) of land and labor is less than one for MV boro and greater than one for other varieties. But except for local boro, the value is not statistically significantly different from unity. This indicates the existence of constant returns to scale in rice cultivation.

The elasticity of land is generally higher, and that of labor lower, for the cultivation of MVs than for traditional varieties. Only in the case of the boro season is elasticity of labor found to be higher for MVs than for local varieties. In the boro season, boro MVs compete for land with local aus (grown on high land) more than with local boro (grown on extremely low land). Compared with local aus, the elasticity of labor is lower for MV boro.

The estimates of marginal productivity of land and labor, at the mean level of application of the inputs, are reported in Table 28. In estimating the marginal productivity of land, the output elasticity of land is taken as the difference of the elasticity of labor from unity, since constant returns to scale prevails. The table also compares the value of the marginal productivity of land with the rent paid by sharecroppers to landowners, and the value of labor with the average farm-specific wage rate paid to hired casual laborers in the cultivation of crops during the survey year. The following major points can be noted from the table.

Compared with local aus, the marginal product of land is about 5.3 times higher in the cultivation of MV aus and 4.8 times higher in the cultivation of MV boro. In the aman season, the increase in the marginal product in MV cultivation is less, but compared with the local variety, it is still about 2.2 times higher. In the boro season, however, the increase in productivity from use of modern technology is only about one-twelfth, but compared with local aus, which is the main substitute crop, the productivity increase is about 4.8 times. Thus modern technology gives tremendous scope for increasing the net returns from the fixed endowment of land that the farmer has.

The effect of modern technology on increasing the productivity of labor is small. Compared with local varieties, the marginal product of labor is higher for MVs by about 51 percent for the aus season, 41 percent for the boro season, and only 5 percent for the aman season. The difference would not be statistically significant, as indicated by

Table 28—Estimates of average and marginal products of land and labor, crop level, 1982

Season/ Variety	Land		Labor			
	Average Productivity	Marginal Productivity	Average Productivity	Marginal Productivity	Rent[a]	Wage Rate[b]
	(Tk/acre)		(Tk/day)		(Tk/ acre)	(Tk/ day)
Aus						
Local	1,302	579	23.25	12.90	841	12.92
Modern	4,613	3,054	57.66	19.49	2,596	17.64
Aman						
Local	2,371	1,209	43.91	21.52	1,418	20.09
Modern	4,342	2,718	60.30	22.55	2,390	21.75
Boro						
Local	3,627	2,553	44.23	13.09	2,022	20.00
Modern	4,386	2,759	49.84	18.49	2,897	23.88

Source: Estimated from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey data.

[a] The value of rent is based on actual production, share rental, and input shares received from landowners in the cultivation of rental land.

[b] These are average farm-specific wage rates paid to hired workers in the cultivation of the crop.

the high standard error of estimate of the elasticity of labor (Table 27). It may also be noted that most of the increase in the marginal product of labor is passed on to workers in the form of higher wages. The workers, however, gain more through additional employment under the new crops (Chapter 4).

Efficiency in the allocation of resources is determined by comparing the marginal product of the factor with its price. According to neoclassical theory, allocation of resources is at optimum when the marginal product of the resources is equal to their prices. In Bangladesh, under sharecropping—the most common tenancy arrangement—the tenant pays 50 percent of the gross produce as rent to the landowner. In the cultivation of MVs, the landowner sometimes shares half the cost of fertilizer and irrigation.[61] The survey found that less than 1 percent of the cost of material inputs was paid by the landowner. The value of rent reported in Table 28 is based on actual production of rented-in land, rent paid by the tenant, and the input cost shared by the landowners. For aus and aman varieties, the marginal product of land is lower than the rent for the local varieties, indicating that the tenants have to pass on a portion of the return on their labor in the form of rent in order to get the land. For MVs, the marginal product of land is higher than the rent—14 percent for the aman season and 18 percent for the aus season. Thus the tenants tend to gain with the diffusion of modern technology in these seasons. For the boro season MVs, however, the marginal product of land is lower than the rent.

Labor seems to be optimally allocated during the aus and aman seasons, as its marginal product is almost in line with the wage rate for the four crop varieties grown during these seasons. During the boro season, however, the marginal product is lower than the wage rate, indicating overutilization of this input. This is usually the slack season of agricultural activity. Nearly half of the land remains fallow during the boro season (Table 26). Only about one-fourth of the land is cultivated with rice. Pulses and oilseeds, which are low-labor-intensive, are the major crops grown during the season. It appears from the findings that farmers facing underemployment of family workers are willing to accept low returns for labor during this season.

Relative Economic Efficiency

In recent economic literature, a profit function model, derived by the application of duality relation between the cost and the production function, is used to measure and compare economic efficiency and price efficiency for groups of farms.[62] Although the model has been severely criticized,[63] its use for empirical studies remains popular. The model is appropriate for the present analysis, as farm households can be classified into two groups, adopters and nonadopters of the modern technology, and their relative economic efficiency compared.

---

[61] M. Raquibuz Zaman, "Sharecropping and Economic Efficiency in Bangladesh," *The Bangladesh Economic Review* 1 (No. 2, 1973): 149-172. It is found from this survey that 39 out of 72 farmers who cultivated modern-variety boro on rented land received some input from the landowner, but the value of the landowner-supplied input was only 0.8 percent of the cost on account of seeds, fertilizer, irrigation, and pesticides. The incidence of cost-sharing was even less for other crops.

[62] Pan A. Yotopoulos and Lawrence J. Lau, "A Test for Relative Economic Efficiency," *The American Economic Review* 63 (No. 1, 1973): 214-223.

[63] See, for example, John Quiggin and Anh Bui-Lan, "The Use of Cross-Sectional Estimates of Profit Functions for Tests of Relative Efficiency: A Critical Review," *Australian Journal of Agricultural Economics* 28 (No. 1, 1984): 44-55; and Ramesh Chand and J. L. Kaul, "A Note on the Use of the Cobb-Douglas Profit Function," *American Journal of Agricultural Economics* 68 (No. 1, 1986): 162-164.

In the model, farms are assumed to have fixed endowments of land, L, and capital, K, which cannot be varied in the short run, but farms can choose variable inputs, labor, N, and fertilizer, F, whose prices are W and C, respectively.[64] The amount of variable inputs that the farm decides to use is determined by setting the marginal cost of the input i to $1/P_i$ times the marginal value product, where P is considered the opportunity cost of the input supplied from the farm family. Farms are called price efficient if all the P_i are equal to unity. One farm may be more technically efficient than another if it produces a larger quantity of output from the same quantities of measurable inputs. Technical efficiency may differ between two groups of farms by a multiplicative factor, δ. Differences in economic efficiency among groups of farms may be caused by differences in technical or price efficiency or both.

Under the assumption of Cobb-Douglas technology, the model yields a unit output price (UOP) profit function:[65]

$$\mathrm{Ln}\pi = \mathrm{Ln}A + \delta T + \alpha_1 \mathrm{Ln}W + \alpha_2 \mathrm{Ln}C + \beta_1 \mathrm{Ln}L + \beta_2 \mathrm{Ln}K, \tag{3}$$

and input demand equations:

$$-WN/\pi = \alpha_{11}T + \alpha_{12}(1-T) \quad \text{and} \tag{4}$$

$$-CF/\pi = \alpha_{21}T + \alpha_{22}(1-T), \tag{5}$$

where π is the unit output price profit (gross revenue minus total variable cost), W and C are, respectively, labor and fertilizer prices normalized by the output price, and T is a dummy variable taking value 1 for MV adopter farms and 0 for nonadopters.

The hypothesis of equal relative economic efficiency implies that δ is equal to zero. The hypothesis of equal relative price efficiency implies that $\alpha_{11} = \alpha_{12}$ and $\alpha_{21} = \alpha_{22}$. The hypothesis of absolute price efficiency implies that for adopter farms, $\alpha_{11} = \alpha_1$ and $\alpha_{21} = \alpha_2$, and for non-adopter farms, $\alpha_{12} = \alpha_1$ and $\alpha_{22} = \alpha_2$.

The error terms are assumed to be additive with zero expectation and finite variance for each of the three equations. But the covariances of the error of either equation corresponding to different farms are assumed to be identically zero. Under this specification of errors, Zellner's seemingly unrelated regression equation (SURE) provides an asymptotically efficient method of estimation.[66] The efficiency of estimation can be increased by imposing known constraints on the coefficients in the equation.[67]

In estimating the model from the data, profits have been measured by deducting farm-specific costs of variable inputs—seed, fertilizer, manure, pesticides, irrigation, and labor—from the gross value of output. The cost of animal labor could not be counted because of nonavailability of data. It has been treated as a fixed input and included in farm capital. The cost of family labor has been imputed by the wage rate paid to hired workers. It was mentioned earlier that the market for irrigation was very imperfect, and the irrigation charge varied widely depending on the source of supply of water. Since the MV crops were irrigated (Chapter 4), the cost of irrigation was also imputed by multiplying the area under MVs by the average cost of irrigation per unit of land for the entire sample. The prices of variable inputs at the farm level could be computed only for labor and fertilizer, since information on both quantity and cost was available only for these two inputs. For this reason, only fertilizer and labor could be used as variable inputs on the right-hand side of the profit equation. A significant proportion of farmers (9.5 percent) did not hire labor or use chemical fertilizer, so prices could not be computed for them. These cases have been dropped because of the nonavailability of farm-specific prices. The profits, wage rate, and fertilizer price variables have been normalized by paddy prices. The capital input has been measured in flow terms by multiplying the replacement cost of the stock of agricultural implements and draft animals by the rate of interest charged on loans from commercial banks.

---

[64] The profit function is estimated for the sample farm households for all crops taken together. Since over 90 percent of the farmers used fertilizer on one crop or another, fertilizer was included as a variable production input, since output elasticity of fertilizer is often used as an important parameter in policy analysis (such as estimating costs and benefits of fertilizer subsidy). Also, information on farm capital was available at the household level and not at the crop level, so this variable could be included in the profit but not in the crop-specific production function reported earlier.

[65] For details of the derivation, see Yotopoulos and Lau, "A Test for Relative Economic Efficiency," pp. 215-218.

[66] A. Zellner, "An Efficient Method for Estimating Seemingly Unrelated Regressions and Test for Aggregation Bias," *Journal of the American Statistical Association* 57 (No. 2, 1962). 348-368.

[67] Yotopoulos and Lau, "A Test for Relative Economic Efficiency," p. 219.

Because of widespread crop damage from natural calamities during the reference year of survey, and the use of the wage rate as the opportunity cost of family labor, the profits were negative for a large number of cases (99 out of 475 farms in the sample). Since the UOP profit function is log linear, these cases had to be excluded. Since lower profits may also be due to inefficiency of resource use, this might introduce sample selection bias in the results. It is found from the tests of the difference of arithmetic means that farms making negative profits are one-third smaller in size and use 48 percent less fertilizer, but are not significantly different in adoption of modern varieties and use of capital services when compared with farms making profits (Table 29).

A major criticism of the model is that the invariability of the prices in the cross-section data vitiates the usefulness of the methodology.[68] This is not found to be a serious problem for the data set used here. Since the sample was selected from a large number of villages scattered throughout the country, and a number of villages are located in

Table 29—Selected characteristics of profitable and unprofitable sample farms, 1982

Variable	Farms Showing Profit (N = 331)	Farms Showing Loss (N = 99)	Percent Difference[a]	Estimated t-Value	Level of Significance
	(acres)				
Average amount of land owned	3.10	1.97	−37	−2.95	0.003
	(percent)				
Cropped area under modern varieties	36	37	1	0.28	0.777
	(kilograms)				
Fertilizer use per acre of cropped land	78	41	−48	−4.02	0.000
	(Tk)				
Capital services per acre of cropped land	298	334	12	0.61	0.543

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Values for farms showing losses over those for farms showing profits.

---

[68] Quiggin and Bui-Lan, "Use of Cross-Sectional Estimates," pp. 44-45.

interior areas with underdeveloped infrastructural facilities, differences in prices across locations were quite significant, particularly for labor and fertilizer. The coefficient of variation of prices across villages was found at 24 percent for labor, 14 percent for fertilizer, and 7 percent for paddy.[69]

The results of the tests of various hypotheses regarding the absolute and relative price efficiency in the use of labor and fertilizer, and also of constant returns to scale in production, are presented in Table 30. The hypothesis that the price efficiency is the same for the adopter and nonadopter farms is accepted for labor but rejected for fertilizer. The χ^2 value for the equality of the parameters in the fertilizer demand equation for the two groups is highly statistically significant. Both groups are absolutely price inefficient in the use of labor and fertilizer. But when the hypothesis of equal relative efficiency in the use of labor is maintained, both groups appear to be absolutely price efficient in the use of fertilizer. The hypothesis of constant returns to scale is also accepted.

The estimates of the parameters of the profit function and the factor share equations are presented in Table 31. The technology dummy is found to be highly statistically significant and the value of the parameter is positive, indicating that the adopter farms are more economically efficient. Even under the assumption of equal price efficiency for labor and constant returns to scale, the technology dummy remains statistically significant, the value indicating that the adopter farms are also more economically efficient, compared with the nonadopter farms, by about 29 percent.

In estimating profits, the cost of family labor was imputed at the wage rate paid to hired workers. This may be a very restrictive assumption, as the opportunity cost of labor could vary across farms, depending on the availability of family labor. To see the bias created by this assumption another explanatory variable was incorporated in the

Table 30—Tests of hypothesis of relative and absolute price efficiency and constant returns to scale

Test	Parameter Restriction	χ^2 Value	Significance Level
Relative efficiency in use of labor	$\alpha_{11} = \alpha_{12}$	1.19	0.275
Relative efficiency in use of fertilizer	$\alpha_{21} = \alpha_{22}$	7.85	0.005
Absolute efficiency in use of labor	$\alpha_{11} = \alpha_1$ $\alpha_{11} = \alpha_{12}$	8.25	0.016
Absolute efficiency in use of fertilizer	$\alpha_{21} = \alpha_2$ $\alpha_{21} = \alpha_{22}$	7.86	0.020
Absolute efficiency in use of fertilizer for adopter farms maintaining equal relative efficiency in use of labor	$\alpha_{21} = \alpha_2$ $\alpha_{11} = \alpha_{12}$	1.19	0.549
Absolute efficiency in use of fertilizer for nonadopter farms maintaining equal relative efficiency in use of labor	$\alpha_{22} = \alpha_2$ $\alpha_{11} = \alpha_{12}$	1.31	0.518
Constant returns to scale	$\alpha_{11} = \alpha_{12}$ $\alpha_{21} = \alpha_2$ $\beta_1 + \beta_2 = 1$	5.09	0.166

---

[69] The price variations are almost of a similar range to those reported in a study of Philippine rice growers by J. Flinn, K. Kalirajan, and L. Castillo, "Supply Responsiveness of Rice Farmers in Laguna, Philippines," *Australian Journal of Agricultural Economics* 26 (No. 1, 1982): 39-48.

Table 31—Joint estimates of profit functions and input demand equations, 1982

Variable (Parameter Restriction)	Parameter	Unrestricted Equation	Restricted ($\alpha_{11} = \alpha_{12}$ $\alpha_{21} = \alpha_2$ $\beta_1 + \beta_2 = 1$)	Restricted ($\alpha_{11} = \alpha_{12}$ $\alpha_{22} = \alpha_2$ $\beta_1 + \beta_2 = 1$)
Profit function				
Constant	LnA	−0.368 (−0.97)	−0.824 (−2.76)	−0.807 (−2.71)
Technology dummy	δ	0.258 (2.50)	0.282 (2.92)	0.288 (2.98)
Log wage rate	α_1	−0.368 (−2.52)	−0.312 (−2.21)	−0.305 (−2.15)
Log fertilizer price	α_2	−0.179 (−0.52)	−0.158 (−6.31)	−0.058 (−1.93)
Log land	β_1	0.767 (11.95)	0.882 (33.14)	0.882 (33.14)
Log capital services	β_2	0.128 (4.73)	0.118 (4.44)	0.118 (4.44)
Labor demand				
Adopter dummy	α_{11}	−1.058 (−5.52)	−0.953 (−0.582)	−0.956 (−5.83)
Nonadopter dummy	α_{12}	−0.653 (−2.06)	−0.953 (−5.82)	−0.956 (−5.84)
Fertilizer demand				
Adopter dummy	α_{21}	−0.172 (−6.09)	−0.158 (−6.31)	−0.158 (−6.31)
Nonadopter dummy	α_{22}	−0.019 (−0.40)	−0.058 (−1.89)	−0.058 (−1.93)
χ^2 for restriction	. . .	. . .	5.08	5.32
Level of significance	. . .	. . .	0.166	0.150

Note: Figures in parentheses are asymptotic t-values, $\bar{R}^2 = 0.50$, and the sample size consists of 331 profit-making farms.

profit function, FLBR, which is measured by the proportion of labor supplied from the farm family. If the opportunity cost of labor depends on the availability of family labor, this variable should be a proxy of the price of family labor. If the variable is statistically significant, the hypothesis that the opportunity cost of family labor is equal to the wage rate can be rejected.

The unrestricted joint estimates of the profit function and the labor demand relations are as follows:

$$
\begin{array}{rl}
\mathrm{Ln}\pi = & \underset{(0.71)}{-0.274} + \underset{(3.26)}{0.343\,\mathrm{T}} - \underset{(-5.33)}{0.698\,\mathrm{LnW}} - \underset{(-0.50)}{0.195\,\mathrm{LnC}} \\
+ & \underset{(10.6)}{0.702\,\mathrm{LnL}} + \underset{(3.26)}{0.122\,\mathrm{LnK}} - \underset{(3.85)}{0.702\,\mathrm{FLBR}}; \qquad (6)
\end{array}
$$

$\bar{R}^2 = 0.52, \ N = 331;$

$$WN/\pi = -1.05\,T - 0.65\,(1-T), \text{ and} \quad (7)$$
$$\qquad (-5.52) \quad (-2.05)$$

$$WC/\pi = -0.171\,T - 0.019\,(1-T). \quad (8)$$
$$\qquad (-6.09) \quad (-0.40)$$

The figures within parentheses are asymptotic t-values.

The coefficient of FLBR is negative and highly statistically significant. Thus the estimated profits decline with increased use of family labor, indicating that the opportunity cost of family labor is lower than the wage rate. Inclusion of this variable increases the value of the coefficient of the price of labor (LnW) from −0.37 in the previous estimate (Table 31) to −0.70. Since family labor has been incorporated as a separate variable, W can now be interpreted as the price of hired labor. The hypothesis that the value of parameter (α_1) is equal to the parameters of the labor demand relation ($\alpha_{11} = \alpha_{12}$) was also tested. The tests produced a χ^2 value of 2.59 with a significance level of 0.17, which can be taken to mean that the farmers are absolutely price efficient in the use of hired labor.

Maintaining the hypothesis that the farmers are both absolutely and relatively price efficient in the use of hired labor and that constant returns to scale prevails, the following estimate of the profit function is produced:

$$\begin{aligned} \text{Ln}\pi \; = \; & -1.378 + 0.331\,T - 0.747\,\text{LnW} - 0.073\,\text{LnC} \\ & (-5.73) \quad (3.28) \quad (-7.38) \qquad (-0.20) \\ + \; & 0.895\,\text{LnL} + 0.105\,\text{LnK} - 0.570\,\text{FLBR}. \qquad (9) \\ & (34.13) \qquad (3.28) \qquad (-3.24) \end{aligned}$$

The coefficient of FLBR suggests that a 10 percent increase in the proportion of family labor reduces profits by 5.7 percent. Even after incorporating the effect of the lower cost of family labor, the coefficient of the technology variable (δ) remains positive and highly statistically significant. The value of the coefficient indicates that the adopter farms get about 33 percent more output from a given level of input than the nonadopter farms.

The output elasticity of various inputs for the Cobb-Douglas production function can be derived indirectly from joint estimates of the parameters of profit function and input demand equations. The estimates are statistically more consistent than the ones derived from the direct estimates of the Cobb-Douglas production function, which assumes all inputs to be exogenously determined, while in practice the variable inputs may be simultaneously determined, depending on prices, which is the maintained assumption in the profit function model. Since α_1 and α_2 appear in both the profit function and the respective input demand equations, imposing the restriction that they are equal in both equations, the efficiency of the estimates is improved. The parameters can also be estimated by imposing the condition of constant returns to scale ($\beta_1 + \beta_2 = 1$). In the estimates derived from equation (7) (unrestricted), the elasticity of land is 0.37, compared with a 50 percent share rental paid by sharecroppers to landowners in Bangladesh. It renders a marginal return of Tk 2,000 per acre. The elasticity of fixed nonland capital assets is estimated at 0.06, showing the relative unimportance of this input, which yields a return of Tk 1.1 per unit of investment. The elasticity for hired labor is 0.37, which yields a marginal productivity of Tk 22.00 per day of labor against an average wage rate of Tk 19.50 paid by the sample farms. The elasticity of fertilizer is estimated at 0.10, which gives a marginal return of Tk 2.10 per unit of taka investment in this input.

The estimate from the unrestricted profit function thus shows considerable inefficiency in the allocation of fertilizer. As indicated earlier, the inefficiency is mainly due to farms that produce local varieties on which fertilizer is used in small amounts. The new crops are not only more technically efficient, they allow farmers to achieve higher levels of allocative efficiency by creating conditions to use more fertilizer per unit of land.

Conclusions

Diffusion of the modern technology increases the effective supply of land by reducing the proportion of fallow land during the dry season. The sown area under cereals is about 87 percent of the cultivated land for unirrigated plots—on irrigated plots it is 150 percent. The increase in the intensity of cereal cultivation is partly at the expense of other crops. Pulses, jute, and sugarcane are grown on about one-third of the unirrigated land, but only 4 percent of the irrigated land is allocated to these crops. With the provision of irrigation facilities, the cropping intensity of the land increases by one-third.

Technological diffusion would increase marginal returns from land many times and provide scope to the landowner to earn more from this scarce resource through the gradual reallocation of land from local to modern varieties. The increase is about five times for the aus and boro seasons and 2.2 times for the aman season. The marginal product of labor is almost the same for the alternative varieties in the aman season, but in the aus and boro seasons the productivity is higher by about 50 percent for the modern varieties. Labor tends to gain more from additional employment than from the increase in marginal product.

The adopters of the new technology are absolutely price efficient in the allocation of fertilizer compared with the nonadopters, but both groups are absolutely price inefficient in the use of labor. The inefficiency in the use of labor is mainly due to low opportunity cost of family labor. The marginal product of hired labor is found to be close to the wages paid. The adopter farms are more technologically efficient than the nonadopter farms by about 33 percent. Diffusion of the new technology would thus improve the efficiency of resource utilization in agriculture.

6

FARM SIZE, TENANCY, AND ADOPTION OF MODERN TECHNOLOGY

A crucial factor in determining equity implications of the new rice technology is the extent and intensity of its adoption among different groups of farmers. The literature is full of studies that analyze adoption behavior of farmers to test the hypothesis that gains from the introduction of the new agricultural technology have been unequally distributed.[70] Most of the evidence for the early period of the green revolution suggests that the incidence of adoption is positively related to farm size, which appears counterintuitive, given the evidence that the new technology is seemingly scale neutral. It is argued that the new technology may entail some fixed costs in the form of access to information and sources of supply of the new inputs, and arrangements for marketing, which tend to discourage adoption by small farmers.[71] The role of tenurial arrangements in the adoption decision is also a subject of considerable controversy. A number of recent studies, however, argue that even if small farmers and tenants initially lag behind in adopting the new technology, they eventually catch up and ultimately may use it more than the large owner-farmers.[72] But even if this is the case, the early adopters can accumulate more wealth and power, which they can use for further accumulation of land from the laggards, thereby establishing a process of unequal distribution of income with the diffusion of the new technology.

To assess the equity implications of the modern technology for Bangladesh, this chapter studies adoption behavior among different size and tenurial groups of farmers and tests pertinent major hypotheses put forward in the literature. Major issues raised in the literature are outlined in the following section. Next, a descriptive account of the intensity of adoption among different groups of farmers is given. The factors affecting adoption are then analyzed, using multivariate regression techniques. The final section investigates the differences in land productivity and prices faced by different groups of farmers, since these also have a bearing on the income distribution effect of the new technology among farmers.

The Issues

The relationship between farm size and adoption of the new technology cannot be determined a priori. Farm size is often a surrogate for a large number of factors[73] that may have an important bearing on the adoption decision. Since the importance of these factors varies across space and over time, variant relationships between farm size and the rate of adoption are observed in empirical investigations.

---

[70] This is in fact an overresearched issue. There are also a large number of surveys of the literature. See, among others, Lipton, *Modern Varieties;* Michael Lipton, "Inter-farm, Inter-regional and Farm-nonfarm Income Distribution: The Impact of the New Cereal Varieties," *World Development* 6 (No. 3, 1978): 319-337; Gershon Feder, Richard E. Just, and David Zilberman, "Adoption of Agricultural Innovations in Developing Countries: A Survey," *Economic Development and Cultural Change* 33 (No. 2, 1985): 255-298; M. Prahladachar, "Income Distribution Effects of the Green Revolution in India: A Review of Empirical Evidence," *World Development* 11 (No. 11, 1983): 927-944; and Richard Perrin and Don Winkelmann, "Impediments to Technical Progress on Small Versus Large Farms," *American Journal of Agricultural Economics* 58 (December 1976): 888-894.

[71] Pears, *Seeds of Plenty,* p. 120.

[72] Vernon W. Ruttan, "The Green Revolution: Seven Generalizations," *International Development Review* 19 (No. 4, 1977): 16-23.

[73] R. Albert Berry and William R. Cline, *Agrarian Structure and Productivity in Developing Countries* (Baltimore: Johns Hopkins University Press, 1979).

An important factor is the degree of risk aversion among farmers.[74] Apart from the objective risk of having uncertain returns on investment under conditions of weather variation and pest attacks, the new varieties entail in the initial years a subjective risk of having an uncertain yield with an unfamiliar technique, the full intricacies of which have not yet been mastered by the farmer. The more risk averse is the farmer, the less willing he will be to adopt, and even if he adopts, he will try to minimize the risk by devoting a smaller proportion of land to the new crops. The degree of risk aversion may depend on the farmer's income. If the farmer operates around the poverty level, he will want to ensure survival for self and family by avoiding the risk of falling below the subsistence level. Since farm size and income may be highly correlated, the small farmer may be more risk averse and less likely to adopt the new technology than is the large farmer. In the case of Bangladesh, a large majority of farmers operate near the subsistence level. But the new technology is now sufficiently known to the farmers and the objective risk is found to be lower for the new crops (Chapter 4), so the risk-aversion factor may not be important in explaining adoption behavior.

The need for working capital to cultivate a given amount of land is higher for the new crop varieties (Chapter 4). For farmers who need to invest in indivisible irrigation equipment like tubewells and power pumps, adoption of the new crops would also require a large initial fixed investment. So, unless the government bears the cost of irrigation development, access to capital in the form of accumulated savings or financial institutions may be an important determinant of the rate of adoption. In many low-income countries, small farmers have limited access to financial institutions. Thus the credit constraint may induce farmers to borrow from the high-cost noninstitutional sources. Working capital constraints may, however, be eased considerably after a few years if the small farmer can accumulate the incremental profits from cultivation of the new crops.

Access to information about sources of new inputs, knowledge about how they can be optimally used, and marketing of the additional output can also be an important factor in determining the differential rate of adoption.[75] The level of education of the farmer can be taken as a proxy of this variable. Since the opportunity cost of sending children to school rises with poverty, educational status is generally found to be positively related to farm size. The larger farmer who is better educated may have more contact with the extension agents who supply this information. Thus the large farmer is expected to have a higher rate of adoption.

A number of other factors may, however, operate to encourage more adoption among the smaller farmers. The new crops use substantially more labor input per unit of land. In rice cultivation, which depends more on the use of casual workers (hired on a daily basis), this labor requirement makes the problem of labor management more difficult and may prevent adoption of the new crop by relatively labor-scarce large farmers. If the new crop increases the seasonal demand for labor, it is less attractive to farmers with a limited supply of family labor.

According to the Chayanovian theory of peasant economy,[76] the consumption unit of the family in relation to the production unit (land and worker) may be an important determinant of the adoption of the new technology. This theory argues that the motive force behind the economic activity of a peasant family is the consumption need, which increases with the growth of the family. The peasant responds to the increased consumption requirement by substituting labor for leisure and by acquiring more land. In land-scarce countries, the possibility of accumulating land is limited for the peasant. In this situation, the yield- and income-raising technology provides the opportunity for increasing consumption from the same amount of land. Hence the new variety is more attractive to small farmers who have more family members relative to land.

---

[74] Feder, Just, and Zilberman, "Adoption of Agricultural Innovations," pp. 262-265.

[75] Pears, *Seeds of Plenty.*

[76] A. V. Chayanov, *The Theory of Peasant Economy*, ed. David Thorner (Homewood, Ill.: Richard D. Irwin, 1966).

The impact of tenurial arrangement on adoption decision is a matter of considerable controversy in the theoretical literature.[77] Bhaduri, citing the East Indian experience, argues that the landlord who derives income from rent as well as from usury is interested in keeping tenants perpetually indebted. Under these circumstances, it is in the landlord's interest not to allow tenants to adopt the new technology, since higher incomes from cultivation of the same amount of land would reduce the tenants' indebtedness, and the loss in usury income would outweigh the gain in rental income accruing to the landlord. This hypothesis has, however, been criticized on the ground that if the landlord has sufficient monopoly power to withhold adoption of the new technology, it should also be possible to siphon off the extra income of the tenant by increasing the rent. Newberry argues that under uncertain labor and product markets, sharecroppers would be interested in adopting the new technology. But Bardhan shows through a theoretical model that land-augmenting technical change and higher labor intensity—the characteristics of the new rice varieties—would induce a higher incidence of tenancy. The risk-aversion theory implies that share tenancy may be a preferred arrangement for adoption of the new technology, since the risk can be shared by the tenant and the landlord. Also, since the tenant is usually a small farmer with more surplus labor and higher subsistence pressure, adoption of the new technology may be easier for the tenant than for the owner-cultivator.

The availability of complementary inputs can also influence adoption behavior. In the case of new varieties of rice, an important factor is the assured and regulated supply of water (that is, irrigation) without which the new variety would be more risky and less profitable. In Bangladesh, with small farms and fragmented and scattered holdings, irrigation seems to be exogenously determined, since the facilities are developed by the government largely with externally funded projects. Even with private ownership of irrigation equipment by large landowners, which has increased somewhat since the late 1970s, the small and medium farmers have an equal chance of having some of their plots located within the command area because of the random location of fragmented holdings. Under these circumstances, the differential adoption among farmers and regions would depend on the location of irrigation projects and on access of the different groups of farmers to irrigation facilities.

---

[77] Amit Bhaduri, "A Study in Agricultural Backwardness under Semi-feudalism," *Economic Journal* 83 (March 1973): 120-137; David Newberry, "Tenurial Obstacles to Innovations," *Journal of Development Studies* 11 (July 1975): 263-277; Ajit K. Ghose and Ashwani Saith, "Indebtedness, Tenancy and the Adoption of New Technology in Semi-feudal Agriculture," *World Development* 4 (April 1976): 305-320; Pranab K. Bardhan, "Agricultural Development and Land Tenancy in a Peasant Economy: A Theoretical and Empirical Analysis," *American Journal of Agricultural Economics* 61 (No. 1, 1979): 48-56; and Pranab K. Bardhan and T. N. Srinivasan, "Crop Sharing Tenancy in Agriculture: A Theoretical and Empirical Analysis," *American Economic Review* 61 (No. 1, 1971): 48-64.

Pattern of Adoption

Farm Size and Adoption of MVs

Table 32 summarizes the observed pattern of adoption of new crop varieties among different groups of sample farmers in the study villages. About three-fourths of the farmers cultivated the new varieties, although only about one-third of the sown area was allocated to them. The proportion of adopter farmers is not found to be significantly different among different size and tenurial groups. The gains from the new technology thus appear to be widely distributed, irrespective of the landholding and tenurial status of the farmer.

The intensity of adoption is, however, found to vary inversely with farm size. The farmers who own less than 2.5 acres of land (henceforth called small farms) devoted about 43 percent of the cropped area to modern rice varieties; among farmers who own 5.0 acres or more (large farms), the proportion was 33 percent. The same pattern is observed even if the intensity of MV adoption is measured as a proportion of sown area under rice. The result appears contradictory to the general findings on this issue in the South Asian context. The previous studies on the extent of adoption for Bangladesh, however, found a similar pattern. One of the more rigorous earlier studies (based on data for 1972), conducted by Asaduzzaman, found that small farmers devoted about 28 percent of the aman rice area to the new crops compared with only 14 percent for large farmers.[78] Herdt and Garcia reviewed findings of seven studies conducted between 1969 to 1981 and noted that five of these reported higher intensity of adoption among smaller farmers.[79] The 1983-84 agricultural census also supports this finding.[80] The census found about 26 percent of the net cropped area for the small farms was under rice MVs, compared with 23 percent for medium farms and 18 percent for large farms.

Table 32—Adoption of modern varieties of rice, by farm size and tenancy, 1982

Farm Group	Share of Farms Adopting Modern Varieties	Share of Area Under Modern Variety Rice	
		Total Cropped Area	Rice Area
		(percent)	
Size of farm			
Small (less than 2.5 acres)	75	43.2	51.7
Medium (2.5–5.0 acres)	74	35.8	44.6
Large (5.0 acres or more)	77	32.5	42.4
Tenurial status			
Owner	77	35.7	44.1
Tenant or owner with tenants	74	38.1	48.1
All farms	75	36.8	46.0

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

---

[78] M. Asaduzzaman, "Adoption of HYV Rice in Bangladesh," *The Bangladesh Development Studies* 7 (No. 3, 1979): 23-49.

[79] Herdt and Garcia, "Adoption of Modern Rice Technology."

[80] Bangladesh, *Census of Agriculture and Livestock.*

Tenancy and Adoption of MVs

The adoption of MVs is not found to be significantly different between owner and tenant farmers. In Bangladesh, pure tenants, that is, those who rent the entire holding, are rare. Most of the tenants are part-tenants who own some land and rent some to make the holding viable. As can be noted in Table 32, 75 percent of the owner-tenants cultivated some land with MVs, compared with 77 percent for the owner-cultivators. The intensity of adoption was about 38 percent for tenants, compared with 36 percent for owners. For rice, tenants devoted 48 percent of the sown area to MVs, compared with 46 percent for owners.

Table 33 shows the incidence of tenancy in the cultivation of different varieties of rice. It is found that tenants are the larger proportion of farmers cultivating MVs in all three rice-growing seasons. The proportion of area under tenancy is also found to be higher in the cultivation of MVs in all three seasons. This indicates a positive effect of the new technology on tenancy cultivation.

In Bangladesh the predominant tenancy arrangement is sharecropping, under which the gross output is shared equally between tenant and landowner, while most of the cost of cultivation is borne by the tenant.[81] It can be argued that under these circumstances, the tenant would be discouraged from adopting the new technology because he would have to bear the large incremental cost of labor, fertilizer, and irrigation, while the incremental output would be shared equally between tenant and landowner. The empirical observation thus appears inconsistent with this hypothesis. Under certain circumstances, however, the hypothesis cannot be tested by comparing the performance of the owner and tenant cultivator, particularly when the tenant also cultivates some owned land. If markets (such as those of labor and capital) are imperfect, the resource position of the cultivator may determine the opportunity cost, which would vary among cultivators. The tenant who has some underemployed resource (human or animal labor) that cannot be sold in the market may hire land. Since the new technology is labor-using, the tenant may want to maximize family income by devoting more land to the new crops than the owner-cultivator. The disincentive effect of share tenancy thus can only be assessed by comparing the rate of adoption on owned and sharecropped portions of the holding under the same cultivator. This is done in Table 34. It is noted that

Table 33—Incidence of tenancy, by season and technology, 1982

Season	Proportion of Farmers Renting Land		Rented Area as a Proportion of Sown Area	
	Traditional Variety	Modern Variety	Traditional Variety	Modern Variety
		(percent)		
Aus	24.6	30.7	14.3	15.9
Aman	27.9	44.7	19.0	20.1
Boro	16.0	35.0	7.5	16.9

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

---

[81] Mahabub Hossain, "Nature of Tenancy Markets in Bangladesh Agriculture," *Journal of Social Studies* 3 (No. 1, 1979): 1-24; F. Tomasson Jannuzi and James T. Peach, *Agrarian Structure of Bangladesh: An Impediment to Development* (Boulder, Colo.: Westview Press, 1980).

Table 34—Adoption of modern varieties on owned and rented land for mixed-tenant farmers, by season, 1982

Season	Owner Farms	Owner-with-Tenant Farms	
	Share of Land Under Modern Varieties	Share of Owned Land Under Modern Varieties	Share of Rented Land Under Modern Varieties
		(percent)	
Aus	33.3	38.8	36.1
Aman	33.5	42.1	35.1
Boro	76.7	82.6	89.0
All seasons	44.1	49.8	46.5

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

tenants devoted a larger proportion of their owned land to MVs than did owner-cultivators, which is a reflection of the negative farm-size effect on MV cultivation, since most tenants are small farmers. But tenants allocated a smaller proportion of rented land than of owned land to the new crops during the aman and aus seasons. This distinction supports the hypothesis of disincentive effect of crop-sharing arrangements. Only during the boro season did tenants grow MVs more on their rented land than on their owned land. This may be due to a stipulation by the landowner that the land can be rented only if it is cultivated with MVs. It was found during the field survey that in many cases the land is only rented seasonally, and seasonal tenancy is more prevalent during the boro season.

Irrigation and Adoption of MVs

The sample villages under study differ widely in access to irrigation, types of irrigation, and length of experience with irrigation. In three villages located in Comilla District, irrigation facilities were developed and MVs introduced in the late 1960s during experimentation with the Comilla model of "cooperative capitalism." Two of the sample villages are under the Ganges-Kobtak project—the first large-scale irrigation project developed in Bangladesh—where irrigation is provided by gravity canals. These two villages got access to the irrigation canals in 1972. Two other villages irrigated part of the land by fielding low-lift pumps on canals developed by the food-for-work program in 1978. In another two villages, irrigation was introduced only two years before this survey by a few large landowners who invested in shallow tubewells. At the time of the survey, five villages did not have any access to irrigation facilities—three of them located in the coastal district of Khulna, where intrusion of saline water during the dry season makes irrigation development difficult. This diversity in the sample allows investigation of the role of irrigation in adoption among different groups of farmers in the early- and late-adopter villages.

The importance of irrigation in the adoption of MVs was shown earlier (Table 25) in the analysis of the pattern of land use for irrigated and unirrigated plots. Further analysis of the use of owner-operated plots shows the crucial importance of land elevation and access to irrigation in the intensity of adoption of MVs (see Table 35). Only 6 percent of the unirrigated plots were used for growing MVs, compared with 77 percent of the irrigated plots. MVs were grown much more on the plots located on the medium-elevation land than on extremely high and extremely low-lying plots, because the

Table 35—Adoption of modern varieties, by land elevation and access to irrigation facilities, 1981

Type of Land	Number of Plots in Sample	Plots Having Irrigation Facilities	Plots Not Growing Modern Varieties	Plots Growing Modern Varieties Once	Plots Growing Modern Varieties Twice
		(percent)			
Elevation					
Extremely high	1,063	14.6	89.6	7.7	2.7
Medium high	1,383	52.3	52.4	24.2	23.4
Medium low	941	44.3	62.3	33.0	4.7
Extremely low	181	16.0	83.4	13.3	3.3
Access to irrigation					
Unirrigated	2,242	0.0	94.0	5.5	0.5
Irrigated	1,326	100.0	23.0	47.4	29.6
All plots	3,568	37.2	67.6	21.1	11.3

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

physical characteristics of the extreme elevations do not generally allow regulation of water supply. About half of the plots located on medium-high land were reported to be irrigated, compared to only one-sixth of the plots located on extremely high and low-lying land. Almost one-third of the irrigated plots were used for growing MVs twice during the year, and it appears that land elevation is the most important factor determining intensity of use. More than 23 percent of the plots located on medium-high land were used to grow MVs twice during the year, compared with less than 5 percent for the other land categories. The second MV crop is grown during the monsoon season, so the low-lying plots that remain deeply flooded cannot be used to raise the dwarf MVs. Since the importance of the different types of plots in the landholding portfolio may vary across villages and farmers, the above findings point to the importance of dissociating the effect of physical characteristics of the land in analyzing the effect of socioeconomic factors on the adoption behavior of farmers.

Table 36 compares the pattern of adoption among different farm-size groups between irrigated and unirrigated villages. About 19 percent of the farmers in the unirrigated

Table 36—Adoption of modern varieties in irrigated and unirrigated villages, by farm size, 1982

Farm Size[a]	Share of Adopter Farms		Share of Cropped Area Under Modern Varieties	
	Unirrigated Villages	Irrigated Villages	Unirrigated Villages	Irrigated Villages
		(percent)		
Small	20	87	3.7	59.6
Medium	20	93	2.7	51.4
Large	15	93	0.7	49.5
All farms	19	90	2.2	53.5

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Small, less than 2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

villages allocated some land to MVs, compared with about 90 percent in the irrigated villages, where the proportion of adopters is 87 percent in the small-farm category and 93 percent among medium and large farms. Once irrigation facilities are developed in a village, the gains are widely distributed across the farm-size scale. Even in the late-adopter villages, where only about 27 percent of the cropped land is cultivated with MVs, more than 80 percent of the farmers are adopters (see Table 37). In the late-adopter villages, the smallest proportion of adopters is among small farmers, while in the early-adopter villages, almost all farmers grew MVs. This supports the contention that, with experience, small farmers catch up with the large ones.

The intensity of adoption is observed to be inversely related to farm size, even in the irrigated villages. About 54 percent of the cropped land in these villages is allocated to MV rice—60 percent for the small farms, compared with 50 percent among the large ones (Table 36). The inverse size effect prevails, even in the early-adopter villages (Table 37), indicating that the large farmers remained laggards even with the passage of time. Presumably, facing a shortage of family labor, the large farmers adopted MVs partly through tenants.

The type of irrigation itself may contribute to the differential rate of adoption among farmers. If the irrigation equipment is privately owned, as is often the case with tubewell irrigation in Bangladesh, a large-farmer monopoly in the supply of water can be expected, since the size of the command area and the high initial cost of investment would prohibit tubewell ownership by smaller farmers.[82] In this case, a direct relationship can be expected between farm size and adoption of MV rice. On the other hand, the communal development of irrigation, as in the case of the Water Development Board's large-scale canal irrigation project, may lead to a more egalitarian system of distribution of water supply, and other things remaining constant, the intensity of adoption would be invariant with farm size. To test this hypothesis, the rate of adoption along the farm-size scale was also estimated for different types of irrigation (Table 37). In the case of villages receiving water from canals, no systematic pattern of adoption was found, but with both tubewell and low-lift pump irrigation, the small farmers adopted more, which is contrary to the above hypothesis.

Table 37—Adoption of modern varieties by type of irrigation and length of experience, 1982

	Share of Adopter Farms			Share of Cropped Area Under Modern Varieties		
Village Group	Small Farms	Medium Farms	Large Farms	Small Farms	Medium Farms	Large Farms
			(percent)			
Type of irrigation						
Low-lift pumps	84	95	87	32.6	33.6	23.2
Canals	91	100	100	58.0	49.8	58.9
Tubewells	87	89	92	68.9	60.7	61.3
Length of experience						
Early adopter	98	100	100	74.8	69.3	71.3
Late adopter	79	88	85	29.6	26.5	24.9

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

---

[82] Pears, *Seeds of Plenty*, p. 107.

Adoption of Fertilizers

Nearly nine-tenths of the sample farmers used fertilizers during 1982, although only about half of the plots were treated with fertilizers. The nonusers were mostly among those who grew only traditional varieties of rice. All farmers growing MV boro and aus rice, and 98 percent of those growing MV aman, used fertilizers. The proportion of user farmers was 74 percent for local transplanted aman, 73 percent for local aus, 19 percent for local broadcast aman, and only 6 percent for local boro. Fertilizer adoption is thus very much variety-specific and depends on the type of land and environment.

The pattern of adoption of fertilizers among different groups of farmers can be reviewed in Table 38. The adopter farmers are proportionately more among the larger size groups. But the intensity of use per acre of land is inversely related to farm size. This apparent inconsistency exists because the number of plots under cultivation is higher for the larger farmer, hence the probability of one of the plots falling under the command area of irrigation—and therefore being suitable for growing MV and applying fertilizer—grows with the size of the farm. The amount of fertilizer used per unit of land is thus a more appropriate indicator of adoption behavior than the proportion of user farms. Compared with large farmers, small farmers use about 35 percent more fertilizer per unit of cropped land, and medium farmers about 20 percent more. The extent of use is similar for owner and tenant farmers. Similar findings on differential adoption of fertilizer were noted by the IFDC from its countrywide survey.[83]

A major factor behind the inverse farm-size effect on fertilizer use is that small farmers have a larger proportion of land under MVs (Table 32), which are much more fertilizer-intensive than traditional varieties of rice. To dissociate the cropping-pattern effect, the adoption pattern for specific crop varieties has also been reviewed (Table 38). The inverse size effect prevails in the case of MVs for all three seasons and is highly pronounced in the case of MV boro. For local varieties on which fertilizers are used in small amounts, no systematic pattern of use across the farm-size scale is found. Owner-farmers tend to use more fertilizer on local varieties than do tenants, but no systematic pattern is found for MVs.

Table 38—Use of chemical fertilizers, by farm size and tenancy, 1982

	All Crops		Amount Used in Major Crops				
			Modern Variety			Local	
Farm Group	Farmers Using Fertilizers	Amount of Nutrients Used	Boro	Aus	Aman	Aus	Aman
	(percent)	(kilograms/acre)	(kilograms/acre)				
Farm size[a]							
Small	85.5	24.4	68	47	38	9	8
Medium	92.3	21.9	64	47	39	7	8
Large	95.0	18.1	51	46	30	13	6
Tenurial status							
Owner	87.8	22.2	63	47	36	10	11
Tenant	90.8	21.6	65	46	38	7	4
All farms	89.2	21.9	64	47	37	9	8

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Small, less than 2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

---

[83] For a summary of the findings of previous studies in this regard, see Herdt and Garcia, "Adoption of Modern Rice Technology;" and Hossain, "Fertilizer Consumption," pp. 197-206.

Adoption Behavior: An Econometric Analysis

The size and tenurial status of a farm are often surrogates for other factors that affect the adoption behavior of farmers. To explain the observed pattern of adoption reported in the previous sections, it is thus necessary to do a multivariate analysis of the factors that determine the adoption behavior and the importance of these factors for different groups of farmers. This is attempted here through the use of the multivariate regression technique. First, a probit model is used to identify the factors that affect the decision to adopt MV rice, and then a tobit model is used to explain the extent of adoption.

The following model was estimated by using the probit method to identify factors that affect the farmers' decision on whether to adopt MVs or not:

$$ADPT = f(OWNL, TNC, IRGP, CRDTI, CRDTN, LBR, LNDPC, NAGRI, INFR), \quad (10)$$

where

ADPT = dichotomous adoption variable that takes value 1 for adopter farms and zero for nonadopter farms,

OWNL = amount of land owned by household (in acres),

TNC = proportion of land rented,

IRGP = proportion of land irrigated,

CRDTI = amount of loans received from institutional sources (in Tk 100/acre),

CRDTN = amount of loans received from noninstitutional sources (in Tk 100/acre),

LBR = amount of land cultivated per worker (in acres),

LNDPC = amount of land owned per member in household (in acres),

NAGRI = income from trade and industry per acre of cropped land (in Tk 100/acre),

INFR = index of underdevelopment of infrastructure at the village level.[84]

LBR and LNDPC are measures of labor scarcity and subsistence pressure in the household and are expected to negatively influence the decision to adopt MVs. CRDTI,

---

[84] This is a composite index of infrastructure underdevelopment constructed by Ahmed and Hossain from the village-specific information on access to a number of elements, such as roads, markets, and financial and educational institutions, for a separate study of the effect of infrastructure on rural development. The infrastructure variable significantly affects a number of endogenous variables investigated in the present study, but the results have not been reported here in order not to preempt the findings of the other study. The conclusions of this study remain valid even after inclusion of the infrastructure variable. See Raisuddin Ahmed and Mahabub Hossain, "Infrastructure and Development of a Rural Economy," International Food Policy Research Institute, Washington, D.C., 1987 (mimeographed).

CRDTN, and NAGRI are expected to ease the capital constraint and hence should have a positive influence on adoption decision.

The results of the exercise are presented in Table 39. Estimated equation 1 in the table incorporated only the farm-size and tenancy variables, and they are found statistically insignificant with an extremely low $\bar{R}^2$ for the regression equation (obtained in the OLS estimate of the parameters). The labor-scarcity and subsistence-pressure variables have right signs of the estimated parameters but they are also statistically insignificant. An alternative labor-scarcity variable was measured by the proportion of hired labor (LBRH), but the negative value of the coefficient is also statistically insignificant (equation 3 in the table). Institutional-credit and nonfarm-income variables, in fact, have opposite signs but are not statistically significant. Only irrigation and development of infrastructure are significantly positively associated with the adoption of MVs. When the effects of the other variables are controlled, the proportion of area under tenancy is significantly positively correlated with the adoption variable.

A large number of variables and their measurements were experimented with to select the variables that best explain the extent of adoption of MVs. After careful scrutiny of the results of alternative estimates, the following model is found to best explain the variation of MV adoption in the sample:

Table 39—Factors influencing decision to adopt modern varieties, probit estimate

Variable	Equation 1	Equation 2	Equation 3
Constant	0.452 (4.89)	−0.105 (−0.46)	−0.038 (−0.16)
OWNL	−0.016 (−0.98)	0.015 (0.56)	0.012 (0.47)
TNC	0.802 (0.42)	0.914[a] (3.70)	0.871[a] (3.54)
IRGP	. . .	4.171[a] (10.57)	4.164[a] (10.62)
CRDTI	. . .	−0.371 (−0.25)	−0.056 (−0.04)
CRDTN	. . .	0.324 (0.75)	0.316 (0.73)
LBR	. . .	−0.040 (−0.90)	. . .
LNDPC	. . .	−0.206 (−0.83)	−0.302 (−1.51)
NAGRI	. . .	−0.098 (−0.64)	−0.087 (−0.56)
INFR	. . .	−0.047[b] (−2.08)	−0.047[b] (−2.08)
LBRH	. . .	. . .	−0.239 (−0.82)
$\bar{R}^2$	0.01	0.33	0.33

Notes: The sample consists of 470 farm households. Figures in parentheses are asymptotic t-values. Values of $\bar{R}^2$ are for OLS estimates.

[a] This number is significant at the 0.01 level.

[b] This number is significant at the 0.05 level.

$$MVP = f(IRGP, LBR, FSZ, CRDTI, CRDTN, NAGRI, EDNH, OWNL, TNC), \quad (11)$$

where

MVP = proportion of cultivated area under MVs,

FSZ = number of members in family, which is a measure of consumption pressure in the household, and

EDNH = level of education of head of household (completed years of formal schooling).

Other variables are as explained earlier.

The equation was estimated separately for two seasons. For the overlapping aus and boro seasons, irrigation is a prerequisite for adoption of MVs because the rainfall is scanty and paddling of soil for transplantation of seedlings cannot be done without irrigation. This is also a relatively slack season for agricultural activity, since a significant proportion of land remains fallow. So factors like labor shortage may not be binding constraints for adoption during this season. During the aman season, rainfall is plentiful, so MVs can be grown under rain-fed conditions. But a physical control is imposed by land elevation, since low land remains deeply flooded throughout the season and is thus unsuitable for growing MVs. Since most of the land is cropped during this season, occasional labor shortages may appear. Owing to these differences, the analysis at the seasonal level was thought to be more appropriate. The proportion of medium-high land was used as another explanatory variable, but the coefficient was not found to be statistically significant and, in fact, had a negative sign in the equation for aus and boro seasons. Since irrigation was highly correlated with this variable, the land-elevation variable was dropped in the final estimated equation to avoid the problem of high multicollinearity.

Care must be taken in selecting the method of estimating the parameters of the specified model, since the observed value of the dependent variable has a limited range. This is the case of a limited dependent variable model, and the application of the least square method to the observed data may lead to seriously biased estimates. Since the dependent variable is observed in the range of zero to one, that is, it is censored in both tails, the "two-limit probit" (tobit) model appears to be the most appropriate technique for its estimation. The software LIMDEP developed by Greene[85] for estimation of the tobit model was applied to the data set to get the values of the parameters of the model.

The estimated parameters are reported in Table 40. As expected, irrigation is found to be the most significant variable in determining the adoption rate. The asymptotic t-value for the estimated coefficient is the highest for irrigation compared with all other variables included in the model. Dropping this variable from the equation reduces the value of the adjusted coefficient of determination ($\bar{R}^2$) from 0.47 to 0.08. The comparison of the t-value for this coefficient for the two seasons indicates that for adoption of MVs, irrigation is more important for the boro and aus seasons than for the aman season.

---

[85] William H. Greene, *LIMDEP: User's Manual,* May 1986; William H. Greene, "On the Asymptotic Bias of the Ordinary Least Squares Estimator of the Tobit Model," *Econometrica* 49 (No. 2, 1981): 505-513; and G.S. Maddala, *Limited Dependent and Qualitative Variables in Econometrics* (Cambridge: Cambridge University Press, 1984).

Table 40—Determinants of adoption of modern varieties of rice, 1982

	Boro and Aus Seasons		Aman Season		All Seasons	
Variable	OLS Estimate	Tobit Estimate	OLS Estimate	Tobit Estimate	OLS Estimate	Tobit Estimate
OWNL	−0.291 (−0.65)	−0.484 (−0.99)	0.036 (0.08)	0.002 (0.004)	−0.255 (−0.41)	−0.429 (−0.74)
TNC	0.130[a] (2.74)	0.137[a] (2.99)	0.183[a] (4.00)	0.190[a] (3.73)	0.314[a] (4.70)	0.283[a] (4.64)
IRGP	0.609[a] (14.09)	0.651[a] (11.10)	0.527[a] (12.57)	0.547[a] (10.02)	1.137[a] (18.69)	1.084[a] (12.56)
LBR	−1.305 (−0.95)	−1.639 (−0.88)	0.733 (0.55)	0.581 (0.45)	−0.572 (−0.30)	−0.550 (0.25)
FSZ	0.539 (0.92)	0.743 (1.07)	0.311 (0.55)	0.264 (0.43)	0.850 (1.04)	0.337 (0.38)
EDNH	−0.403 (−1.02)	−0.396 (−0.80)	−0.248 (−0.65)	−0.269 (−0.65)	−0.650 (−1.169)	−0.416 (−0.66)
CRDTI	0.351[b] (1.71)	0.518[c] (2.36)	0.442[c] (2.21)	0.459[c] (2.48)	0.793[a] (2.74)	0.743[a] (2.74)
CRDTN	0.423[a] (4.64)	0.625[a] (5.07)	−0.108 (−1.23)	−0.113 (−0.87)	0.315[a] (2.46)	0.695[a] (3.82)
NAGRI	0.137 (−1.44)	−0.165 (1.46)	−0.126 (−1.368)	−0.134 (−1.10)	−0.264[c] (−1.97)	−0.290[c] (−1.99)
(Constant)	0.14[a] (3.36)	0.14[c] (2.38)	−0.004 (−0.10)	−0.004 (0.06)	0.14[c] (2.33)	0.17[c] (2.34)
(σ)	. . .	33.141[a] (24.58)	. . .	30.19[a] (25.88)	. . .	40.0[a] (19.67)
$\bar{R}^2$	0.36	. . .	0.28	. . .	0.48	. . .
Log-L	. . .	−2,037	. . .	−2,136	. . .	−1,768

Notes: The sample consists of 470 farm households. Figures in parentheses are asymptotic t-values.

[a] This number is significant at the 0.01 level.

[b] This number is significant at the 0.10 level.

[c] This number is significant at the 0.05 level.

The value of the coefficient (in the equation for all seasons) indicates that a 10 percent increase in the area under irrigation may increase the proportion of land under rice MVs by about 11 percent.

The coefficient of the family-worker variable is positive for the aman season, indicating that—given the amount of land to be cultivated—the higher the availability of family labor, the greater the tendency to cultivate MVs. The value of the coefficient, however, is not found to be statistically significant. For the aus and boro seasons, the coefficient of this variable has an opposite sign, but it is not statistically significant. As indicated earlier, this is the slack season for agricultural activity, so households with a lower endowment of labor relative to land may not be constrained in growing more labor-intensive crops, as they can count on easy availability of hired labor.

The coefficient of family size is positive for both seasons, thus supporting the Chayanovian hypothesis that the higher the subsistence pressure, the greater the tendency to adopt the new technology. The relationship, however, is weak. The value of the coefficient is not statistically significant.

In the context of a small-farmer peasant economy as in Bangladesh, the shortage of working capital is often emphasized as a major constraint to adoption of the new technology. In this exercise, the amount of loans received per unit of land has been taken as a proxy of the availability of liquid funds, which may ease the capital constraint. The variable, however, could not be measured as season-specific, so it is difficult to interpret the value of the coefficient of this variable in the equations for different seasons. The value of the coefficient of institutional credit is positive for both seasons, which suggests that the availability of institutional credit facilitates adoption. The coefficient is found to be statistically significant in all the equations at less than 5 percent probability of error. This result may seem surprising, since the access of small farmers to agricultural-credit institutions is still limited, although the supply of agricultural credit from institutional sources increased about eight times (at real value) during 1975-84. During 1983/84, the amount disbursed was about 7 percent of the value added in agriculture and 2.3 times the cost of fertilizer consumed in the country.[86] The credit is concentrated in the hands of the medium and large farmers. In the present sample, only 13 percent of the farm households received institutional loans during 1982, and the amount of institutional loans was about a quarter of the total loans received by them.

The incidence of borrowing from noninstitutional sources was found to be widespread. Nearly two-thirds of the farmers borrowed from friends and relatives—most often without any interest—and also from local moneylenders, who charge very high rates of interest. Nearly 40 percent of the loans from noninstitutional sources were free of interest. The coefficient of the noninstitutional credit variable is found to be positive and statistically significant at less than 5 percent probability of error for the aus and boro seasons. For the aman season, however, the coefficient has an opposite sign, but it is not statistically significant. Because of the need for irrigation and more-intensive use of fertilizer, the working capital requirement for the cultivation of MV crops is significantly higher for the boro and aus seasons than for the aman season (Chapter 4). The proportion of holdings allocated to MVs is also less for the aman season. Thus farmers who do not have access to formal credit institutions may tap noninstitutional loans to cultivate MVs during the dry season, while their own resources may be sufficient for cultivating the small amount of land that they currently allocate to MVs during the aman season.

Farmers who earn some income from nonagricultural sources may have less liquidity constraint than those who depend mostly on agriculture, so access to nonagricultural income may ease the capital constraint to adoption of MVs. The amount of income earned from trade and industry per unit of cultivated land was related to the intensity of adoption in order to test this hypothesis. The value of the coefficient is found to be negative irrespective of the season, which is contrary to the hypothesis. The negative value is statistically significant for all seasons. In fact, it is found in further tests that if the service incomes are added, the t-value for the negative coefficient increases. This indicates that farmers who cannot adopt MVs because of technical constraints (such as nonavailability of irrigation) try to augment household incomes in alternative ways; for example, by self-employment in various nonagricultural activities and by taking temporary low-income employment (such as public works programs). (See Chapter 7 for further details.)

---

[86] The supply of agricultural credit from institutional sources increased about eight times (at real value) during 1975-84. During 1983/84, the amount disbursed was about 7 percent of the value added in agriculture, and 2.3 times the cost of fertilizers consumed in the country. See Mahabub Hossain, "Institutional Credit for Rural Development: An Overview of the Bangladesh Case," *The Bangladesh Journal of Agricultural Economics* 8 (No. 1, 1985): 1-16.

Another variable for which the result is found to be contrary to the a priori hypothesis is the level of education. The value of the coefficient is found to be consistently negative in all equations, thus indicating that the less educated adopt MVs more intensively. This finding tends to support the contention that the type of education provided in schools is not agriculture oriented. Education provides better opportunities for nonagricultural employment, which may be higher paying and less arduous than agricultural employment. Thus, although education gives better access to information about the new technology, it may not necessarily facilitate adoption of the technology.

When the effects of other socioeconomic variables are controlled, the size of landownership does not seem to affect the intensity of adoption. The coefficient of the landownership variable is positive for the aman and negative for the boro season, but the values are not statistically significant. The estimated t-value is less than one for all cases. The tenancy variable, however, still remains highly statistically significant. The positive value of the coefficient indicates that the extent of adoption of MVs is higher on rented land than on owned land. Since MVs are labor-intensive, and tenants rent land to minimize underutilization of family workers, the large landowners may gain more by having sharecroppers cultivate MVs than by self-cultivating them with wage laborers. Since there is so much excess demand for land, the tenancy market may be governed more by the interests of the landowners than by those of the tenants, who would be discouraged by the crop-sharing arrangements from cultivating MVs on rented land.

The higher intensity of adoption on smaller farms, as reported in the previous section, comes mainly through availability of irrigation and incidence of tenancy. Irrigation in Bangladesh is mostly exogenously determined. It is developed by the government, often with foreign assistance. Irrigation has spread mostly in areas where the average farm size is low (the eastern and southeastern parts of the country). In the coastal and flood-prone districts where there are physical constraints to development of irrigation, concentration of land in the hands of large farmers is generally higher. So the proportion of irrigated land is found to be higher on small farms (see Table 41).

Table 41—Incidence of irrigation and tenancy for different groups of farmers

Farm Group	Share of Land Irrigated: Sample Farmers, 1982[a]	Share of Land Irrigated: Bangladesh Agricultural Census, 1983-84[b]	Share of Cropped Area Under Tenancy of Sample Farmers, 1982
		(percent)	
Farm size			
Small	32.3	22.8	37.9
Medium	32.9	19.0	9.9
Large	28.3	18.3	4.0
Tenurial group			
Owner	33.6	n.a.	0.0
Tenant	29.6	n.a.	35.4
All farms	31.7	19.9	15.9

Sources: Bangladesh, Bureau of Statistics, *The Bangladesh Census of Agriculture and Livestock: 1983-84* (Dhaka: Ministry of Planning, 1986); and data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Note: n.a. means not available.

[a] As a percentage of owned land.

[b] As a percentage of cultivated holding. Medium farms are defined in the census as those with 2.5-7.5 acres of operated area.

The same pattern is noted for the country as a whole in the latest agricultural census (1983-84).[87] Tenancy cultivation is also more prevalent among the smaller farmers. It was found in the present survey that about one-sixth of the cropped land was tenant cultivated; the proportion was 38 percent for small farms, compared with only 4 percent for large ones.

Size, Land Productivity, and Prices

The observation that adoption of the new technology is inversely related to farm size does not necessarily imply that in Bangladesh the income distribution effect associated with diffusion of the new technology would be favorable to the smaller farmers. The impact on income distribution would also depend on the variation in productivity and prices among different groups of farmers.

For Bangladesh, many studies show an inverse relationship between farm size and land productivity.[88] Most of the findings are, however, for areas that did not experience significant diffusion of the new technology and refer to time periods (mostly the late 1960s and early 1970s) when the technology was in early stages of adoption. Some of the studies for India,[89] where the size-productivity relationship is also found to be inverse in the case of the traditional crops,[90] argue that this relationship may not hold for the new technology, as it gives considerable scope for using capital. Since the larger farmers have more accumulated savings and also have better access to financial markets, they are in a better position to apply purchased inputs like fertilizer and water more intensively than the smaller farmers. Thus a positive size effect on the yield rates for MVs may be expected, depending on the importance of the new inputs in cultivation of the variety.

The differences in land productivity among the size groups of farms observed in the survey may be reviewed in Table 42. Since the productivity may also vary, depending on the stage of development of the new technology, the sample villages have been classified into two equal groups according to the proportion of area under MVs. The developed villages have about 60 percent higher rice yields than the underdeveloped villages. In the cultivation of MVs the yield is about 14 percent lower in the developed villages, which may be due to diffusion of MVs to marginal farmers and marginal land, as well as to production of two rice crops per year on some land, which reduces the yield of each crop. In the cultivation of local varieties the yield is about 20 percent higher for the developed villages.

The yield is found to be inversely related to farm size in both groups of villages and for both the traditional and modern varieties of rice. The difference in yield between

---

[87] Bangladesh, *Census of Agriculture and Livestock.*

[88] See, among others, Mahabub Hossain, "Farm Size, Tenancy, and Land Productivity: An Analysis of Farm Level Data in Bangladesh Agriculture," *The Bangladesh Development Studies* 5 (No. 3, 1977): 285-348; and M. A. Sattar Mandal, "Farm Size, Tenancy and Productivity in an Area of Bangladesh," *The Bangladesh Journal of Agricultural Economics* 3 (December 1980): 21-42.

[89] Prannoy Roy, "Transition in Agriculture: Empirical Indicators and Results," *Journal of Peasant Studies* 8 (No. 2, 1981): 212-241; and G. S. Bhalla and G. K. Chadha, *Green Revolution and the Small Peasant* (New Delhi: Concept, 1983).

[90] Krishna Bharadwaj, *Production Conditions in Indian Agriculture,* Department of Applied Economics Occasional Paper 33 (Cambridge: Cambridge Unversity Press, 1974); Biplob Dasgupta, *The New Agrarian Technology and India* (New Delhi: Macmillan, 1977); and Pranab K. Bardhan, "Size, Productivity, and Returns to Scale: An Analysis of Farm-Level Data in Indian Agriculture," *Journal of Political Economy* 81 (No. 6, 1973): 1370-1386.

Table 42—Farm size and land productivity, by technology, 1982

Farm Size[a]	Technologically Developed Villages			Technologically Underdeveloped Villages		
	Local Varieties	Modern Varieties	All Rice Varieties	Local Varieties	Modern Varieties	All Rice Varieties
	(metric tons/acre)					
Small	0.72 (0.08)	1.29 (0.13)	1.10 (0.11)	0.63 (0.09)	1.53 (0.38)	0.73 (0.10)
Medium	0.71 (0.09)	1.13 (0.13)	0.93 (0.08)	0.53 (0.07)	1.37 (0.41)	0.58 (0.09)
Large	0.61 (0.14)	1.09 (0.24)	0.86 (0.20)	0.51 (0.12)	1.06 (0.77)	0.57 (0.13)
All farms	0.71 (0.06)	1.23 (0.09)	1.03 (0.08)	0.58 (0.06)	1.43 (0.26)	0.64 (0.07)

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Note: Figures in parentheses are standard errors of estimate.

[a] Small, less than 2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

the small and large farmer is, however, less pronounced for the technologically developed villages than for the underdeveloped ones, suggesting that with diffusion of the technology, the productivity gap narrows to some extent. Still, in the developed villages, the productivity for small farmers is about one-fifth higher than for large farmers, and the difference is statistically significant.

The income from cultivation may also differ across farms due to variation in prices. The new technology has increased the dependence of the farmers on the market for acquisition of the new inputs and also for labor. The prices of the inputs may vary across farms, especially under conditions of underdeveloped infrastructure facilities and monopoly control on the supply of the new inputs. The prices paid by different groups of farmers for the major agricultural inputs can be reviewed in Table 43. The fertilizer prices are reported separately for the dry and monsoon seasons because the prices, which are government controlled, were raised on July 1, 1982, so farmers

Table 43—Prices of major agricultural inputs, by farm size and tenancy, 1982

Farm Group	Fertilizer Price		Irrigation Charge in Boro Season	Wage Rate
	Boro and Aus Seasons	Aman Season		
	(Tk/kilogram)		(Tk/acre)	(Tk/day)
Farm size[a]				
Small	3.20	3.64	672	20.22
Medium	3.23	3.55	583	19.43
Large	3.18	3.51	544	17.73
Tenurial status				
Owner	3.20	3.58	589	18.91
Tenant	3.22	3.62	698	22.88
Total	3.21	3.60	627	19.59

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Small, less than 2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

growing aman crops faced higher prices than those growing boro and aus crops, and the effect of this factor needs to be dissociated.

The fertilizer prices seem to be invariant with the size and tenurial status of the farm, but the water charge and the wage rate vary considerably across farms. The small farmers paid about 24 percent higher prices for water than the large farmers. Tenant farmers paid about 19 percent higher water charges than did owner farmers. This is expected because the ownership and management of irrigation equipment is controlled more by the large landowners. The government started selling deep tubewells and low-lift pumps to individuals and cooperatives in 1979/80. By the end of 1983, some 43 percent of the operating deep tubewells and 56 percent of the low-lift pumps were owned by the private sector. Nearly two-thirds of such machines were owned by households with 5 acres of land or more.[91] The small farmers and tenants also paid substantially higher wage rates than the large landowners. Since the tenants and small farmers come to the labor market during busy periods, when the wage rates are higher, the weighted average wage rate is expected to be higher for them, although for a particular day all farmers may face the same wage rate.

The cost of working capital may also be higher for small farmers because they have to borrow more from the high-cost, noninstitutional sources. This survey found that nearly three-fourths of the small farmers took loans from noninstitutional sources, compared with two-fifths among the large farmers. The institutional sources accounted for 20 percent of the total loans taken by small farmers, compared with 44 percent for the large farmers.

Conclusions

In Bangladesh, small farmers and tenants have adopted the modern technology at least as much as have large farmers and owner-cultivators. The scale neutrality of adoption may have been the result of the government investment for development of irrigation, which is the main vehicle for diffusion of the modern technology. Even under private investment on tubewells and power pumps, small farmers have as much access to irrigation facilities as the large ones because of the randomness with which the extremely fragmented and scattered farm holdings are distributed.

The small farmers, however, pay higher prices for inputs, particularly for water, labor, and working-capital loans. The ownership of privately owned machines and the management of the irrigation cooperatives is controlled by large farmers, who take a sizable markup from the irrigation market. The small farmers paid a water charge about 25 percent higher than the large farmers, and a 10 percent higher wage rate, presumably because the small farmers have to go to the labor market during busier periods of agricultural operations. Since the small farmers have to borrow more from the high-cost informal markets than do the large farmers, the average cost of working capital may also be higher for the small farmers. The variation in the prices of agricultural inputs would thus put a negative pressure on income distribution, which might outweigh the effect of the inverse relationship between farm size and adoption rates.

---

[91] M. Abul Quasem, "Impact of the New System of Distribution of Irrigation Machines in Bangladesh," *The Bangladesh Development Studies* 13 (September-December 1985): 127-140.

7

LABOR MARKET AND EMPLOYMENT EFFECTS OF MODERN TECHNOLOGY

In Bangladesh, nearly a third of rural households do not own any cultivable land, and about a half own less than 0.5 acre; for them, farming is only a marginal source of income.[92] Having no access to land, most of these households are at the bottom of the rural income scale. Their income depends on conditions in the labor market, that is, duration of employment and wage rate. The new technology would affect the agricultural-labor market by changing the labor intensity of cultivation, the productivity of labor, which in turn would influence the wage rate, and the income of the farmer, which would affect his labor/leisure choice. The technology could also indirectly affect the nonagricultural labor market, since the expenditure of the increased agricultural income would generate additional demand for nonagricultural goods and services, some of which might be produced within the locality.[93] The objective of this chapter is to trace these employment effects of the new technology. Although the main focus is on employment generation for the landless and the marginal farmers, employment for the land-owning groups has also been studied, since their self-employment behavior would affect the labor market.

Employment in rural Bangladesh consists mainly of self-employment, and most of the agricultural workers are hired on a daily basis. Workers change jobs from one day to another, from self-employment to wage employment and from agriculture to other forms of employment. Under these circumstances, accurate information on employment can be obtained only through a large number of regular surveys covering a short period, so that respondents can recall what they did during this period. To collect accurate information for the whole year, it would be better to conduct 52 weekly surveys, but that would have been extremely expensive and taxing for the respondents. Considering the trade-offs, this survey collected information for all members of the sample households who participated in productive work for each day of the week preceding the day of interview, for eight weeks scattered throughout 1982. The periods were selected on the basis of a priori knowledge of the cropping pattern of the area so as to represent the normal, busy, and slack periods of employment. The supply of labor for the whole year and the composition of employment has been estimated by extrapolating the data for the eight weeks. The demand for agricultural labor has been estimated from labor use in crops, as reported by farmers in three rounds of interviews conducted at the end of each crop season during 1982.

---

[92] According to the land occupancy survey of 1978, the first attempt in the country to get information on landownership, 15 percent of rural households did not own any land, and 29 percent owned only homestead land. But households that claimed no more than 0.5 acre of land other than the homestead, and are considered in Bangladesh as "functionally landless," constituted 50 percent of rural households in that year. In 1983/84, according to the latest agricultural census, 9 percent of the households did not own any land and 46 percent owned less than 0.5 acre. About 40 percent of the households reported agricultural wage labor as their main occupation; two-thirds of them owned less than 0.5 acre. See Jannuzi and Peach, *Agrarian Structure of Bangladesh*, p. 110; and Bangladesh, *Census of Agriculture and Livestock*, pp. 81, 267.

[93] John W. Mellor, *The New Economics of Growth: A Strategy for India and the Developing World* (Ithaca: Cornell University Press, 1976). For detailed empirical investigations see, among others, Peter B. R. Hazell and Ailsa Roëll, *Rural Growth Linkages: Household Expenditure Patterns in Malaysia and Nigeria*, Research Report 41 (Washington, D.C.: International Food Policy Research Institute, 1983); and Mahabub Hossain, "Agricultural Growth Linkages: The Bangladesh Case," *The Bangladesh Development Studies* 15 (No 1, 1987).

Participation in Economic Activities

A worker has been defined as a person who was available for work in income-earning or expenditure-saving activities (henceforth called economic activities) during any of the eight weeks of the survey. These activities included supervision of farm labor, crop cultivation, postharvest processing and marketing, livestock and poultry raising, commercial and subsistence fishing, vegetable growing in kitchen gardens, cottage industries, house construction and repair, earthwork, collection of fuel, and trade, transport, and other services. Domestic labor for women should also be regarded as expenditure saving for the household, but it was not considered in this definition. The average number of workers, thus defined, is 1.88 persons per household out of a household size of 6.34 persons for the entire sample. Thus the labor force participation rate (workers divided by members) is 29.7 percent of the rural population, which is very close to the 29.4 percent activity rate reported in the national labor force survey of 1983-84.[94] The low rate of participation in economic activities is partly because of the large proportion of the young population (up to age 15), but is mainly due to the virtual absence of women from the country's labor force. About 35 percent of the population in the sample was below age 10, and only 8 percent of the female population participated in economic activities. The rate of participation of women in income-earning activities is estimated at 5.1 percent by the 1981 population census and 7.9 percent by the 1983-84 labor force survey.

The labor force participation rates for different landholding groups can be reviewed in Table 44. The impact of the new technology is assessed by comparing the information

Table 44—Labor force participation in developed and underdeveloped areas, by landholding, 1982

Landownership Group[a]	Average Number of Persons in Family	Average Number of Workers (Age 15 and Over) in Family	Participation Rate	Male Workers as Proportion of Family Members	Female Workers as Proportion of Family Members
			(percent)	(percent)	(percent)
Underdeveloped villages	6.19	1.84	29.7	27.3	7.9
Landless	4.82	1.55	32.2	28.8	10.4
Small	5.98	1.82	30.4	27.7	8.9
Medium	7.04	2.09	29.7	28.4	4.2
Large	8.87	2.21	24.9	22.9	8.0
Developed villages	6.52	1.93	29.6	25.8	12.8
Landless	5.45	1.88	34.5	27.3	21.0
Small	5.93	1.70	28.7	24.6	13.9
Medium	7.38	2.08	28.2	26.0	8.1
Large	9.08	2.52	27.8	26.6	3.9

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Landless, less than 0.5 acre; small, 0.5-2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

---

[94] The crude activity rate is estimated at 30.0 percent for the country as a whole, 34.2 percent for urban areas, and 29.4 percent [illegible] rural areas. See Bangladesh, *Final Report: Labour Force Survey, 1983-84*, p. 25.

for two groups of villages, equally divided according to the scale of the adoption rate of the new technology (see Chapter 2). The average number of persons in the household was about 5 percent higher in the developed villages, and the difference is statistically significant. This difference is, however, mainly due to the landless category. The difference for other groups is not significant. Presumably, better economic conditions in developed villages reduce mortality rates and increase family size for the landless category.

The participation rate is similar in the two groups of villages. The participation of women is, however, marginally higher in the technologically developed villages and is significantly higher for the landless and small farmer groups. The proportion of female workers in landless households is about 21 percent in the developed villages, compared with 10 percent in the underdeveloped villages. This difference may be due to more employment opportunities being generated for women in nonagricultural activities in the developed villages. The number of male workers as a proportion of the total population is about 25.8 percent in the developed villages, compared with 27.3 percent in the underdeveloped villages.

Size of landholding has a strong influence on the participation rate. In the underdeveloped villages, the participation rate is about 32 percent for the landless and marginal landowners compared to 25 percent for the large landowners. Similar differences are found in the developed villages. The female participation rate is also higher among the landless and the marginal landowners, significantly so in the developed areas. With technological advancement, the participation of males in the labor force appears to decline.

The participation rate can be taken as a proxy indicator of the supply of labor in the stock sense. The findings that technological advancement and size of landownership have a negative influence on the participation rate indicate that leisure is substituted for labor at higher levels of income. It appears that the very poor households supply as many workers as possible to the labor force in order to earn a subsistence income for the family, subject to job availability and limitations imposed by socioreligious factors.[95] As income increases with technological progress or a larger amount of land, or both, a household may withdraw the women and children from the labor force in order to have higher social status and better education for the children.

The above point is further demonstrated in Table 45, which shows occupations of family members aged 10 to 25—the age group that participates in the labor force, attends educational institutions, or takes up domestic duties as housewives. The labor force participation rate in this age group is about 27 percent in the developed villages, compared with 37 percent in the underdeveloped villages. Although a larger proportion of the female population in this age group is married and takes up domestic work, the main reason behind the lower participation rate in developed villages is greater participation in educational institutions. The proportion of students in this age group is 36

---

[95] In Bangladesh there is a social stigma against women working in the field or performing manual labor for others. The women from very poor families, however, try to earn or to save expenditures by organizing production around the homestead. About 75 percent of the people who took loans in 1986 from the Grameen Bank, an institution created for providing credit to landless households, were women. They took loans mostly for livestock and poultry raising, cottage industries, and shopkeeping activities. A large survey in 1979 found that nearly two-fifths of the workers employed in cottage industries were women and 84 percent of them were unpaid family laborers. As agricultural incomes increase, the demand for these activities in which the poor women can find employment may also go up. See Mahabub Hossain, *Credit for Alleviation of Rural Poverty: The Grameen Bank in Bangladesh*, Research Report 65 (Washington, D.C.: International Food Policy Research Institute, 1988); and Mahabub Hossain, "Employment and Labour in Bangladesh Rural Industries," *The Bangladesh Development Studies* 12 (March-June 1984): 1-24.

Table 45—Occupation of family members aged 10 to 25, by landownership and sex, 1982

Group	Underdeveloped Villages				Developed Villages			
	Students	Housewives	Inactive	Workers	Students	Housewives	Inactive	Workers
				(percent)				
Landownership[a]								
Marginal	16.4	39.7	9.3	34.6	23.0	37.2	7.5	32.2
Small	18.9	37.8	3.0	40.2	32.1	34.0	3.3	30.6
Medium	27.2	34.7	1.9	36.2	46.2	32.1	2.7	19.0
Large	50.0	24.0	6.0	20.0	57.5	21.3	4.3	17.0
Sex								
Male	29.9	. . .	3.6	66.5	49.6	. . .	7.1	43.3
Female	16.3	71.5	6.4	5.8	22.1	65.6	3.1	9.2
Total	23.1	36.4	4.9	35.7	36.0	32.9	4.7	26.5

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Marginal, less than 0.5 acre; small, 0.5-2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

percent in the developed villages, compared with 23 percent in the underdeveloped villages. A larger proportion of males than of females attends school. With technological progress, the student population increases for both sexes, but the increase is more pronounced for males—about 50 percent in the developed villages, compared with 30 percent in the underdeveloped villages. Size of landownership also significantly influences school attendance. In underdeveloped villages, students compose less than one-fifth of this age group in households owning less than 2.5 acres, but about one-half in households with 5.0 acres of land or more. Even after controlling for the effect of landownership group, school attendance is higher in developed villages.

Education increases the quality of labor and provides opportunity for taking higher-paid nonagricultural employment. Even self-employment in trade, services, and processing activities requires functional knowledge of reading, writing, and arithmetic. Considering the above, the downward pressure of technological advancement on labor force participation should be taken as a positive development. With improved economic conditions, the lower-income groups can afford to send more children to school and have better education, which may promote occupational mobility and increase lifetime earnings.

Extent and Composition of Employment

Since the average number of hours of work per day may vary across villages, and a worker may be engaged in a number of activities during a day, the information on duration of employment was collected in the survey in hours, by activity, for each of the workers in the sample households. The information was collected on a daily basis for seven days preceding the date of the interview and may contain some margin of error due to memory recall. The estimate of total employment at the household and worker levels has been built up from the data and is measured in average weekly employment hours for the eight weeks of the survey. The information can be converted to standard eight-hour days of employment for the year 1982. It may be mentioned here that the figures measure only the supply of labor by the sample households, both on own and others' account, which may not necessarily be equal to total employment generated in the study areas. The estimation of total employment would have required data on in- and out-migration of labor in flow terms, which were not collected by the survey.

The average duration of employment estimated from the survey is about 39 hours per week, or about 253 standard eight-hour days during the year of the survey. About 62 percent of the employment was generated in agricultural activities. Self-employment accounted for about 68 percent of the total employment. The respondent workers reported that they were available for work 345 days a year. On this basis the rate of underemployment is estimated at about 27 percent.[96] However, if six days of work a week is taken as a full-employment norm, then the rate of underemployment on the time criterion is estimated at only 19 percent.

The duration of employment for different landownership groups in the technologically developed and underdeveloped areas can be reviewed in Table 46. It appears from the data that the supply of labor declines with technological advancement. Compared with underdeveloped villages, the supply of labor in developed villages is about 13 percent lower at the worker level and 9 percent lower at the household level. The duration of employment is also inversely related to the size of landownership, reflecting that at higher levels of income, people substitute leisure for labor. The workers belonging to landless households worked, on average, for about 42.4 hours a week, compared with 38.2 hours for workers belonging to households owning 5 acres of land or more—a difference of about 11 percent. With technological advancement, the difference becomes more pronounced—the landless putting in about 24 percent more labor than the large landowners. The reduction in duration of employment is less for the landless than for the landowning groups. In fact, at the household level, the landless in developed villages supply about 14 percent more labor than their counterparts in underdeveloped villages. Thus, by raising incomes, technological progress puts a downward pressure on the supply of labor. As the higher-income groups demand more leisure, the increase in labor demand generated by the new technology is met by increased supply from the lower-income groups; some of it may even be supplied by migrant workers from villages where the technology has not yet developed. In that sense, the comparison of the duration of employment between developed and underdeveloped areas underestimates the positive employment effect of the new technology on the lower-income groups.

The substitution of leisure for labor at higher income levels is more pronounced for arduous agricultural activities. This is shown in Table 47. Labor supply in agriculture is positively related to the amount of land owned, because of greater opportunities for self-employment on larger farms. But with technological advancement, the workers who belong to farm households put in less labor in agriculture than do their counterparts in underdeveloped villages. In contrast, the workers in the landless group supply about 80 percent more labor in the developed villages than in the underdeveloped ones. The total supply of labor in agriculture is about 7 percent more in the developed villages.

---

[96] In rural Bangladesh open unemployment is rare, because family members share the household work, but underemployment is considerable. Estimates of the rate of underemployment for the country as a whole are not available. Estimates from different microstudies for the recent period vary from 28 to 43 percent. A part of the difference is due to regional variations, as most of the studies cover only a few villages in different areas of the country, but a large part of the variation can also be attributed to differences in concepts and definitions, particularly regarding the full employment norm. See Atiq Rahman and Rizwanul Islam, "Labor Use in Rural Bangladesh: A Study with Micro-Level Data," International Labour Organisation, Asian Employment Programme, Bangkok, 1985 (mimeographed); Iqbal Ahmed, "Unemployment and Underemployment in Bangladesh Agriculture," *World Development* 6 (December 1978): 1281-1296: and Mahmud Khan, "Labor Absorption and Unemployment in Rural Bangladesh," *The Bangladesh Development Studies* 13 (September-December 1985): 67-88.

Table 46—Duration of employment in technologically developed and underdeveloped areas, by landownership group, 1982

Landownership Group[a]	Average Employment per Household			Average Employment per Worker		
	Underdeveloped Villages	Developed Villages	Difference	Underdeveloped Villages	Developed Villages	Difference
	(hours/week)		(percent)	(hours/week)		(percent)
Landless	65.37	74.39	13.8	42.40	40.09	–5.5
Small	75.47	63.87	–15.4	42.36	37.26	–12.0
Medium	87.79	66.67	–24.1	41.34	32.53	–21.3
Large	83.87	80.83	–3.7	38.24	32.33	–15.5
Total	76.38	69.62	–8.8	41.59	36.12	–13.2

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Landless, less than 0.5 acre; small, 0.5-2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

The poor cannot afford to remain unemployed. Since the landless do not get enough employment on the land, they tend to engage more in nonfarm rural activities. In underdeveloped villages, about 64 percent of the employment for landless households was generated in nonagricultural activities, compared with only 22 percent for the large landownership group (Tables 46 and 47). As agricultural income increases with technological advancement, more demand is generated for nonfarm goods and services, some of which may be produced in rural areas (see Chapter 8). This may increase demand for labor in nonagricultural activities. It appears from the data that the additional employment is taken up by households in underdeveloped villages and by large landowning groups in developed villages. The supply of labor in nonagricultural activities is about one-third lower in the developed villages. The rate of decline increases with size of landownership but only up to the medium-sized farm group. The supply of labor to nonagriculture from the large landowning group is, in fact, greater in the developed villages.

Table 47—Duration of employment in agricultural and nonagricultural activities, by technology and landownership group, 1982

Landownership Group[a]	Agriculture			Nonagriculture		
	Underdeveloped Villages	Developed Villages	Difference	Underdeveloped Villages	Developed Villages	Difference
	(hours of labor/week/household)		(percent)	(hours of labor/week/household)		(percent)
Landless	23.61	42.43	79.7	41.76	31.96	–23.5
Small	42.16	41.03	–2.7	33.31	22.84	–31.4
Medium	60.66	53.24	–12.1	27.13	13.43	–50.5
Large	65.42	60.53	–7.5	18.45	20.30	–10.0
Total	43.54	46.67	7.2	32.84	22.95	–30.1

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Landless, less than 0.5 acre; small, 0.5-2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

Employment in some of the nonfarm activities whose market is expanded by increased rural incomes may require investment in working capital and some basic skills, such as functional reading, writing, and arithmetic, that can be acquired in schools. The poor may be constrained in taking up nonagricultural employment opportunities by widespread illiteracy and lack of access to financial institutions. Thus they may engage more in farming and in those nonfarm activities that require more manual labor than physical or human capital. This may often be distress employment, that is, very low productivity jobs taken by a worker when he has nothing else to do. As technological progress generates opportunities for additional employment in farming and increases the productivity of agricultural labor, employment in nonfarm activities is replaced by employment in agriculture.

Table 48 gives a detailed breakdown of employment by activity for all workers in the sample. The complete lack of specialization in rural employment is striking. Even farming does not generate enough employment for a household to keep one worker busy throughout the year. Rice farming poses the additional problem of the seasonal pattern of demand for labor, so even in large landowning households, family workers may remain unemployed during slack seasons of the year. A household may be engaged simultaneously in a number of agricultural and nonagricultural activities, and a worker may be engaged in a number of activities during the same week. It will be noted from the table that although 95 percent of the households participate in agricultural work, more than 90 percent also have some nonagricultural occupations. Nearly half of the households in the underdeveloped villages report miscellaneous nonagricultural activities (such as fencing and collection of fuel), which generate less than six hours of employment on average in a week for the households participating in such activities.

The activities for which the duration of employment declines with technological advancement are agricultural wage labor, cottage industry, trade and shopkeeping, earthwork, and miscellaneous jobs. Agricultural labor and earthwork are arduous and

Table 48—Labor supply in different activities in developed and underdeveloped areas, for all rural households, 1982

			Average Weekly Employment			
	Share of Households Engaged in the Activity		Households Engaged in the Activity		All Households	
Activity	Underdeveloped Villages	Developed Villages	Underdeveloped Villages	Developed Villages	Underdeveloped Villages	Developed
	(percent)		(hours)			
Agriculture	93.7	95.9	46.46	49.15	43.53	47.13
Cultivating family farms	81.1	80.3	34.34	34.64	27.85	27.82
Wage labor	45.3	40.1	23.54	22.98	10.66	9.21
Livestock and poultry raising	41.2	53.2	8.25	9.73	3.40	5.18
Fishing	18.6	26.4	8.76	18.60	1.63	4.91
Nonagriculture	92.5	90.5	35.52	25.62	32.86	23.19
Cottage industry	12.3	7.3	27.14	8.83	3.34	0.65
Trade and shopkeeping	31.1	26.1	24.74	21.31	7.70	5.56
Construction and transport	41.2	38.2	20.09	15.80	8.28	6.04
Services	21.7	38.9	26.40	19.20	5.73	7.46
Earthwork	27.4	14.0	14.48	13.61	3.97	1.91
Other	56.0	43.6	6.87	3.56	3.85	1.55

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

are also considered socially degrading if the work is performed for others. With increases in income, some households can afford to avoid this type of work. Miscellaneous activities may be performed when there is nothing else to do, so with increased employment opportunities, these are replaced by other work. The decline in labor supply to industry and trade, however, is surprising. Presumably, with increases in income, people tend to replace some low-quality products of cottage industries (often called dying industries) with competing products of formal industries, located mostly in urban areas. Also, labor productivity in many cottage industries and in petty trade is very low—even lower than the agricultural wage rate.[97] So when people do not find any work, they engage in these activities as self-employed workers. As the demand for, and the productivity of, agricultural labor increases with technological progress, these activities may be relocated to the underdeveloped villages where they may increase employment opportunities for the lower-income groups. Further investigation is necessary to test this hypothesis.

Labor Market

General Conditions

The size of the labor market is found to be quite small. Only about 32 percent of the labor hours were supplied against wages—22 percent in the agricultural sector and 49 percent in the nonagricultural sector (see Table 49). This is not surprising, since the typical holding in agriculture is too small to provide full employment for family workers, and many agricultural workers generate nonfarm employment on their own account in response to the lack of employment in the crop-production sector.

Table 49—Size of labor market from the supply side, by sector, 1982

	Share of Households Supplying Labor in the Market			Wage Labor as a Share of Total Labor		
Sector	Under-developed Villages	Developed Villages	Both Groups	Under-developed Villages	Developed Villages	Both Groups
			(percent)			
Agricultural	49.9	40.1	43.0	25.0	19.9	22.3
Nonagricultural	56.3	50.0	53.2	48.2	49.1	48.6
Total	67.9	63.4	65.7	35.0	29.5	32.3

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

---

[97] On estimates of productivity of labor in cottage industries and petty trade, see Mahabub Hossain, "Productivity and Profitability of Bangladesh Rural Industries," *The Bangladesh Development Studies* 12 (March-June 1984): 127-161; and Mahabub Hossain, *Credit for the Rural Poor: The Grameen Bank in Bangladesh,* Research Monograph 4 (Dhaka: Bangladesh Institute of Development Studies, 1984), pp. 77-94. The former study found that if the cost of family labor is imputed by the agricultural wage rate, the profit becomes negative for a large number of cottage industries, such as net and rope making, cane and bamboo works, mat making, and rice processing by indigenous methods, which account for about one-third of cottage industry employment. These activities are undertaken to raise household income through employment of female labor and of male labor during off-peak agricultural seasons. Such labor has very little opportunity cost.

Although the labor market is small, most of the cultivators hire labor at some time or other during the year (see Table 50). The labor-hiring households are a large majority, even among small farmers cultivating less than 2.5 acres. This may be the result of seasonality in the demand for agricultural labor. At busy periods labor must be hired to supplement family labor, while during slack periods members of the same household will seek jobs in the labor market.

Because of the seasonal variation in demand and supply, the rural labor market is generally informal in nature, and most workers are hired casually, on a daily basis, according to the need. During the survey year, only one-eighth of all farmers and one-half of the large farmers hired workers for a season or for the year. Two-fifths of those hired on a regular basis were children who looked after livestock and were mostly employed for wages in kind—free board, meals, and clothing. Such employment is often determined by the level of absolute poverty in a village rather than by the demand for regular workers by an employer.

Impact of Technology

Technological progress increases the demand for labor in the agricultural sector. In the crop production activity, labor hired on a casual basis accounts for 47 percent of the total labor used in the technologically developed villages, compared with 41 percent in the underdeveloped villages (Table 50). The proportion of hired labor increases even for the small-farmer group. So there is a downward pressure on the supply of hired labor from farming households. This is one of the reasons why the proportion of labor supplied in the agricultural market is lower in the technologically developed villages (20 percent) than in the underdeveloped villages (25 percent), while the labor supplied in the nonagricultural market remains unchanged (Table 49).

Table 51 shows that most of the agricultural labor in the market is supplied by the landless and marginal landholding groups. In the underdeveloped villages, 68 percent of the landless participate in the labor market and 74 percent of their employment is generated by others; the proportions are 13 and 3 percent, respectively, for the large landownership group. In the developed villages, labor supplied against wage is lower than in underdeveloped villages for all landholding groups, and the difference is more pronounced for large landowners. In the nonagricultural sector, also, the participation rate in the market is inversely related to the size of landownership. But unlike in

Table 50—Nature and size of agricultural labor market from the demand side, by landownership group, 1982

	Share of Farmers Hiring Long-Term Workers		Share of Farmers Hiring Daily Labor		Hired Labor as a Share of Total Labor	
Landownership Group[a]	Underdeveloped Villages	Developed Villages	Underdeveloped Villages	Developed Villages	Underdeveloped Villages	Developed Villages
	(percent)					
Small	4.6	2.0	76.2	87.1	30.3	34.4
Medium	17.5	14.3	90.2	96.0	36.0	47.1
Large	54.8	33.3	100.0	100.0	55.9	60.2
All groups	15.4	9.5	84.5	91.1	40.6	46.7

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Small, less than 2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

Table 51—Participation in labor market for different landownership groups, 1982

	Agriculture				Nonagriculture			
	Share of Households Supplying Wage Labor		Share of Labor Supplied Against Wage		Share of Households Supplying Wage Labor		Share of Labor Supplied Against Wage	
Landownership Group[a]	Underdeveloped Villages	Developed Villages	Underdeveloped Villages	Developed Villages	Underdeveloped Villages	Developed Villages	Underdeveloped Villages	Developed Villages
				(percent)				
Landless and marginal	67.7	73.7	74.0	52.5	74.0	69.5	51.8	58.3
Small	50.0	39.4	29.0	15.0	66.4	51.9	54.2	47.3
Medium	27.2	17.3	7.8	2.9	37.0	32.1	41.7	40.8
Large	12.9	2.9	2.9	0.3	16.1	32.4	10.0	27.1

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Landless and marginal, less than 0.5 acre; small, 0.5-2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

agriculture, the supply of labor in the market does not change much with technological advancement. In fact, the supply of wage labor in the nonagricultural market is higher in developed villages for the landless and large landowner groups. Thus the tendency to avoid agricultural wage employment at higher levels of income and to shift to nonagriculture in response to higher employment opportunities puts a downward pressure on the supply of agricultural labor when technology progresses. These forces operate to provide more employment and income to the lower-income groups.

The wages received for hired-out labor (excluding payment in kind) in the two groups of villages are shown in Table 52. The wage rate was higher for nonagricultural labor than for agricultural and higher for male workers than for female. The agricultural wage rate for women was 44 percent lower than for men in the underdeveloped

Table 52—Wage rate received for hired labor, by technology, landholding, and sex of workers, 1982

Technology/Family Landholding	Male Workers		Female Workers	
	Agriculture	Nonagriculture	Agriculture	Nonagriculture
		(Tk/hour)		
Underdeveloped villages	1.53	1.95	0.68	1.16
Less than 0.5 acre	1.46	1.74	0.53	1.21
0.5–2.5 acres	1.61	2.15	1.34	1.25
2.5 acres or more	1.68	2.25	[a]	0.72
Developed villages	1.82	2.86	1.22	1.52
Less than 0.5 acre	1.86	2.46	1.21	1.13
0.5–2.5 acres	1.79	3.03	[a]	1.75
2.5 acres or more	1.63	3.29	[a]	1.91

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Notes: The wages exclude meals as payment in kind. The estimates for female workers for different landholding groups would be unstable, as they are based on a very small number of cases because female participation in the labor market is negligible.

[a] There was no case in this category.

villages. The comparison suggests that technological progress has a positive effect on the wage rate. For male workers, the agricultural wage rate in developed villages was 19 percent higher than in underdeveloped villages, and the nonagricultural wage rate was 47 percent higher.

The wage rate paid by sample farmers for agricultural labor was about 25 percent higher in technologically developed villages than in underdeveloped ones (see Table 53). The difference in wage rate was higher for the small landowners (30 percent) than for large ones (16 percent). Thus, while the landless gain from the higher wages following technological progress, this factor increases inequality in agricultural incomes across the farm-size scale.

Operation of the Labor Market—A Multivariate Analysis

An important limitation of the analysis presented above is that it is based on a partial approach, since only two factors—the size of landownership and technology—are taken into account. The labor market would be affected by a host of other factors, including the wage rate, whose effects also need to be controlled for in assessing the impact of the new agricultural technology. This section attempts to broaden the analysis by applying the multivariate regression technique.

Determinants of Labor Supply

Following Yotopoulos and Lau, and Bardhan,[98] the supply of labor by a rural household is assumed to be governed by the following function:

$$\text{SLBR} = f(\text{OWNL, TECH, CPTL, FSZ, WRKR, FEM, EDCN, LVNG, VWAGE}), \qquad (12)$$

where

SLBR = average weekly hours of labor put in by household,

OWNL = amount of land owned by household (in acres),

TECH = amount of land cropped with MVs (in acres),

CPTL = amount of nonland fixed assets owned by household (in Tk 1,000),

FSZ = number of members in household,

WRKR = number of family workers in household,

---

[98] Yotopoulos and Lau derive a labor supply function of the household from an indirect utility function, while Bardhan employs a pragmatic approach to explain the labor market participation behavior of peasant households. See Pan A. Yotopoulos and Lawrence J. Lau, "On Modeling the Agricultural Sector in Developing Economies," *Journal of Development Economics* 1 (No. 1, 1974): 105-127; and Pranab K. Bardhan, "Labor Supply Functions in a Poor Agrarian Economy," *American Economic Review* 69 (March 1979): 73-83. Other major works that cover this issue are Lawrence J. Lau, W. L. Lin, and Pan A. Yotopoulos, "The Linear Logarithmic Expenditure System: An Application to Consumption-Leisure Choice," *Econometrica* 46 (July 1978): 843-868; and Mark R. Rosenzweig, "Rural Wages, Labor Supply, and Land Reform: A Theoretical and Empirical Analysis," *The American Economic Review* 68 (December 1978): 847-861.

FEM = number of female workers in household,

EDCN = educational level of head of household (completed years of schooling),

LVNG = standard of living in the village as measured by per capita consumption expenditure, and

VWAGE = wage rate prevailing in the village (in taka per day).

In the utility function of an individual, leisure is considered as one of the consumer goods. Its cost is the wage income that has to be sacrificed if leisure is consumed. This cost would reduce the purchasing power of other consumer goods. So the choice between leisure and consumer goods will be determined by their relative prices, that is, the wage rate and the prices of consumer goods. An increase in income from nonwage sources will shift the indifference curve upward; hence the individual can have more leisure and consumer goods at the same level of relative prices. Thus labor, which is the residual of the time available for work after the consumption of leisure, would be determined mainly by the wage rate, the prices of consumer goods, and the income from nonwage sources. It would be positively related to the wage rate and negatively related to the prices of consumer goods. Owing to the difficulty of measuring the index of the prices of a large number of consumer goods, it has not been possible to incorporate this variable in the labor supply function. Since the labor market is more fragmented, owing to the difficulty of worker mobility, a much larger variation is expected in the wage rate among the cross-section of households than in the prices of consumer goods. The omission of this variable thus may not seriously affect the results.

The main determinants of nonwage income are the assets owned by the household. The variables OWNL, TECH, CPTL, and EDCN have been incorporated to take care of the effect of this factor. The larger the amount of land owned by the household and the proportion of the land devoted to cultivation of MVs, the higher would be nonlabor agricultural income. The nonland fixed assets would provide scope for generating

Table 53—Wage rate paid by sample farmers for agricultural labor in technologically developed and underdeveloped villages, 1982

	Underdeveloped Villages		Developed Villages		
Landownership Group[a]	Number of Farmers Hiring Labor	Wage Rate	Number of Farmers Hiring Labor	Wage Rate	Difference in Wage Rate (Developed Over Underdeveloped)
		(Tk/day)		(Tk/day)	(percent)
Small	86	17.19	128	22.26	30
Medium	74	17.63	72	21.28	21
Large	27	16.34	32	18.90	16

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Note: The wages include imputed value of payments in kind. The mean wage rate for the entire sample was Tk 19.59, and the standard error of estimate was Tk 0.26. The difference in wage rate between developed and underdeveloped villages was statistically significant for all groups. The Bangladesh Bureau of Statistics estimated the wage rate for the country as a whole at Tk 17.05 for 1982/83.

[a] Small, less than 2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

self-employment in nonagricultural activities, while education might open up opportunities for shifting to relatively higher-paid employment in service activities and hence for earning higher income from the same amount of labor. Thus, while capital and education may have a positive effect on nonagricultural employment, the higher-income effect would put negative pressure on the supply of labor. The net impact would depend on the magnitude of these two opposite effects.

The decision regarding the consumption of goods and services and the supply of labor is determined at the household level, so the composition of the household and of the working members may also affect the supply of labor. The higher the number of consumers (FSZ) relative to workers, the lower would be the per capita income from labor in the household, and hence the higher would be the supply of labor. The larger the proportion of female workers, the lower would be the supply of labor, since women also have to supply domestic labor and would have less time available for productive work. Thus, other things remaining constant, labor supply would be positively associated with family size and negatively associated with the number of female workers.

In estimating labor-supply functions, questions are raised about appropriate measurement of the wage rate as an independent variable.[99] The wage rate derived from the information on wage earnings and labor hours worked outside the household, if incorporated in the function where the latter is used as the dependent variable, would pose well-known measurement-error problems. For households that do not sell labor, the variable cannot be observed. The problem of simultaneity is also involved because, at the household level, both the amount of labor supplied and the wage rate may be jointly determined by other variables. To avoid these problems, the prevailing wage rate for agricultural labor in the village has been used for all households. As Bardhan points out, the village wage rate may be more exogenous to the individual household than the wage actually received, which may be determined by such factors as the amount of labor supplied and the level of income of the household.

The labor supply functions estimated from the data for all households in the sample, for agriculture and nonagriculture, and for self-employment and wage employment, are reported in Table 54. The total supply of labor seems to be significantly related to all the variables included in the function. The model explains about two-thirds of the variation in the supply of labor among the sample households. A worker supplies on the margin about 30 hours a week, about three-fifths of which are on own account of the household (self-employment) and in the agricultural sector. A larger number of dependents seems to necessitate more work by the earner. This additional work is, however, generated mainly in agriculture and on own account of the household. The coefficient of the family size variable is statistically insignificant and has an opposite sign in the equation for nonagriculture and wage employment. This indicates that such employment may be demand-determined; that is, even if the household is willing to supply additional labor to satisfy the consumption needs of a larger number of dependents, the employment may not be available in the market. A female worker puts in about 11 hours fewer per week than an average worker if she is employed in agriculture, but in nonagriculture the difference is insignificant.

The larger the amount of land owned by the household, the smaller is the supply of labor, which supports the a priori expectation about labor/leisure substitution. Ownership of land, however, gives scope for generating more employment in agriculture, particularly on own account. The value of the coefficient of land in the equation

---

[99] Bardhan, "Labor Supply," pp. 74-75.

Table 54—Estimates of labor supply functions for all rural households, 1982

Variable	All Activities	Agriculture	Nonagriculture	Self-employment	Hired Employment
VWAGE	1.10[a]	0.07	1.03[a]	0.58[b]	0.52[c]
	(4.71)	(0.29)	(3.73)	(2.12)	(1.93)
LVNG	−1.47[a]	−0.97[a]	−0.50[c]	−0.33	−1.15[a]
	(−6.51)	(−4.00)	(−1.88)	(−1.22)	(−4.44)
OWNL	−1.09[a]	0.77[c]	−1.86[a]	1.36[c]	−2.45[a]
	(−2.80)	(1.83)	(−4.04)	(2.97)	(−5.49)
TECH	−2.18[a]	1.86[a]	−4.04[a]	0.04	−2.57[a]
	(−2.95)	(2.34)	(−4.65)	(0.46)	(−3.05)
CPTL	0.34[a]	0.16[c]	0.18[c]	0.58[a]	−0.23[b]
	(3.89)	(1.74)	(1.72)	(5.58)	(−2.31)
FSZ	1.28[a]	1.55[a]	−0.27	1.99[a]	−0.71
	(3.34)	(3.78)	(−0.61)	(4.42)	(−1.63)
WRKR	31.06[a]	18.34[a]	12.72[a]	18.03[a]	13.03[a]
	(27.73)	(15.23)	(9.47)	(13.68)	(10.18)
FEM	−11.27[a]	−11.13[a]	−0.14	−2.39	−8.88[a]
	(−4.76)	(−4.38)	(−0.05)	(−0.86)	(−3.29)
EDCN	−0.66[b]	−1.44[a]	0.78[b]	−0.23	−0.43
	(−2.42)	(−4.91)	(2.43)	(−0.71)	(−1.39)
Constant	32.60[a]	28.34[a]	4.26	−4.77	37.36[a]
	(4.38)	(3.54)	(0.88)	(−0.54)	(4.39)
$\bar{R}^2$	0.67	0.47	0.21	0.47	0.27
N	624	624	624	624	624
F	140.6	62.2	19.8	62.4	26.4

Note: Figures in parentheses are estimated t-values. The sample size consists of 624 households, with valid observations for all variables.

[a] This number is significant at the 0.01 level.

[b] This number is significant at the 0.05 level.

[c] This number is significant at the 0.10 level.

of self-employment shows that an additional acre of landownership generates 1.36 hours of additional self-employment a week (about 9 days a year). But the positive income effect of landownership reduces the supply of labor in the market by about 2.45 hours a week (16 days a year). Thus, on balance, the total supply of labor is reduced.[100] The results also indicate that the larger the amount of land owned, the less is the need to work in nonagricultural activities. Education gives additional scope for working in the nonagricultural sector, but the higher-income effect of education and the higher social status of the educated worker operate to reduce the worker's supply of labor in agriculture. On balance, the better educated supply less labor in agriculture and on others' account. Among the income variables, only capital seems to increase the supply of labor. It reduces supply for the market, but the positive effect on creation of employment on own account more than compensates for the negative effect, in both agricultural and nonagricultural activities.

---

[100] Values of regression coefficients reported in the table are those obtained by the OLS method. Since some of the cases have zero values for the dependent variable (the number was large for the category of hired employment), the censored regression method is more appropriate for estimation of the supply functions for different categories of employment. The equations were estimated using the tobit method and the parameter values were found to be somewhat different, but the general conclusions remained valid. The OLS estimates were chosen for presentation because the values of the parameters of the specific variables in functions for different categories of labor add up to the parameter for that variable in the supply function for total labor.

The supply of labor responds positively to the wage rate, but mostly for nonagricultural labor. For agricultural labor, the coefficient of the wage variable is statistically insignificant. This is found to be the case for all landownership groups from separate estimates of the supply functions for agricultural labor. The estimated coefficient of the wage rate, valued at the arithmetic mean of the variable, gives an elasticity of supply of nonagricultural labor at 0.71.

Another variable that is found to significantly affect the supply of labor is the standard of living in the village. This variable is measured by the per capita consumption expenditure at the village level. The value of the coefficient is negative and highly statistically significant, indicating that the higher the standard of living in the villages, the smaller is the supply of labor by its households. This variable affects mostly the supply of labor for the market—the negative coefficient in the equation for wage employment is statistically highly significant. The coefficient for self-employment is also negative but not statistically significant. This result suggests that improvement in economic conditions in a village—from whatever sources—would reduce the supply of labor for the market, which would give scope for more employment for workers from neighboring low-income villages or put an upward pressure on the wage rate, or both.

For the present purpose, the coefficient of the technology variable is the point of interest. After controlling for the effects of other variables, the coefficient of the technology variable is negative, indicating that diffusion of the modern technology would depress the supply of labor. The value of the coefficient suggests that an increase of 1 acre under MVs would reduce the supply of labor on the margin by 2.2 hours a week (14 days a year). Technological progress creates opportunities for more employment in agriculture. The value of the coefficient in the equation for agriculture is found to be positive and statistically significant. But by raising incomes, it reduces the need to work in nonagricultural activities. The negative effect on nonagricultural labor is more pronounced than the positive effect on agricultural labor. The difference is presumably due to the income effect of technological progress. Technological progress also reduces the supply of labor for the market. The value of the technology coefficient in the equation for wage employment indicates that an increase of 1 acre under the new technology would reduce the supply of wage labor by 2.6 hours a week (17 days a year).

Table 55 reports the estimated labor supply functions for the landless and marginal landowning households. A close scrutiny of the results shows a behavioral pattern similar to that for all households in the sample, with a few exceptions. The coefficient of the size of landownership is not significant in either of the equations, which is understandable as this group owns only up to 0.5 acre of land. A worker in this group supplies about 30 hours of labor a week, only 2.2 percent less than other groups, but unlike the landowning groups, two-thirds of the labor is supplied to the market—mostly in agricultural activities. The total supply of labor is positively related to the wage rate, but the response is mostly for labor on own account. It appears that when the wage rate goes up, this group reduces hiring of outside labor and replaces it with more self-exploitation of family labor.

Technological progress generates more additional agricultural employment for the landless than for the landowning groups. This is achieved by substituting agricultural for nonagricultural labor. The positive effect on agricultural labor is more pronounced than the negative effect on nonagricultural labor. On balance, the technology has a

Table 55—Estimates of labor supply functions for landless and marginal landowning households, 1982

Variable	All Activities	Agriculture	Nonagriculture	Self-employment	Hired Employment
VWAGE	1.40[a]	0.57	0.89[c]	1.55[a]	−0.15
	(3.25)	(1.41)	(1.67)	(2.74)	(−0.27)
LVNG	−1.41[a]	−1.55[a]	0.14	0.02	−1.42[a]
	(−3.92)	(−3.71)	(0.31)	(0.03)	(−3.00)
OWNL	−5.00	−2.21	−2.80	0.24	−5.25
	(0.68)	(0.26)	(−0.30)	(0.03)	(−0.54)
TECH	1.14	8.24[b]	−7.10[a]	4.76	−3.61
	(0.36)	(2.21)	(−1.68)	(1.13)	(−0.85)
FSZ	3.52[a]	3.12[a]	0.40	3.96[a]	−0.44
	(3.74)	(2.85)	(0.32)	(3.20)	(−0.36)
WRKR	30.38[a]	19.93[a]	10.45[a]	10.43[a]	19.95[a]
	(12.52)	(7.07)	(3.28)	(3.27)	(6.23)
FEM	−2.41	−13.75[a]	11.34[b]	14.85[a]	−17.26[a]
	(−0.58)	(−2.89)	(2.08)	(2.71)	(−3.14)
EDCN	−0.15	−1.31[c]	1.15	0.88	−1.03
	(−0.23)	(−1.76)	(1.38)	(1.05)	(−1.23)
Constant	12.51	15.09	−2.58	−44.88[a]	57.39[a]
	(0.99)	(1.02)	(−0.16)	(−2.67)	(3.42)
$\bar{R}^2$	0.68	0.41	0.17	0.31	0.26
N	191	191	191	191	191
F	52.28	17.02	5.81	11.49	9.35

Note: Figures in parentheses are estimated t-values.

[a] This number is significant at the 0.01 level.

[b] This number is significant at the 0.05 level.

[c] This number is significant at the 0.10 level.

positive effect on labor supply for the landless, although it is not statistically significant. It is also interesting to note that, like the landowning groups, the landless reduce the supply of labor to the market in response to technological progress.

Determinants of Demand for Agricultural Labor

The survey collected information on the demand for labor only for crop-production activity. The information was collected from the farming households at the crop level for three agricultural seasons. Table 56 presents the information for different groups of farm households. The total demand for labor in the crop production activity in the developed villages was about 27 percent higher than in underdeveloped villages. Most of the increase, however, was on account of hired labor. Compared with underdeveloped villages, an average household in the developed villages used 42 additional days of labor, 34 days being met by employment of hired workers. The additional self-employment for family labor is mostly on account of small-farm households. The demand for hired labor was about 56 percent higher in developed villages, and the additional employment was generated more on the small farms (131 percent) than on the large ones (19 percent). It appears that large farmers kept the upward pressure on the wage rate low (Table 53) by hiring labor relatively less than small and medium farmers.

Table 56—Use of labor in crop production in developed and underdeveloped villages, by amount of land owned, 1982

	Family Labor			Hired Labor			Total Labor		
Landownership Group[a]	Underdeveloped Villages	Developed Villages	Difference	Underdeveloped Villages	Developed Villages	Difference	Underdeveloped Villages	Developed Villages	Difference
	(8-hour days/ household)		(percent)	(8-hour days/ household)		(percent)	(8-hour days/ household)		(percent)
Small	52.7	72.0	36.6	19.8	45.8	131.1	72.5	117.8	62.5
Medium	118.4	106.3	−10.2	66.5	94.8	42.6	184.9	201.1	8.8
Large	155.1	155.5	0.3	196.6	234.4	19.3	351.7	389.9	10.9
All groups	90.9	98.5	8.4	61.3	95.3	55.5	152.2	193.8	27.3

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Note: The table excludes the functionally landless households. A few of them were engaged in farming and used farm labor, which is not accounted for.

[a] Small, less than 2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

The following demand function for hired labor was estimated from the data:

$$\begin{array}{llllll} \text{DLBR} = & 68.29 & + \; 8.72\,\text{LAND} & + \; 27.78\,\text{TECH} & - \; 1.64\,\text{WRKR} & \\ & (4.23) & (10.74) & (13.11) & (-0.58) & \\ & - \; 2.27\,\text{VWAGE} & - \; 0.48\,\text{TNC}; & & & (13) \\ & (-2.99) & (-4.00) & & & \end{array}$$

$\bar{R}^2 = 0.49, \quad F = 95.9, \quad N = 461,$

where

DLBR = number of labor days hired from outside the household in the crop production activity,

LAND = total cropped area (in acres),

TECH = area devoted to cultivation of MVs,

WRKR = number of family workers in household,

TNC = total cropped area under tenancy (in acres),

VWAGE = wage rate estimated at the village level (in taka per day).

The figures within parentheses are the estimated t-values of the coefficient. As expected, the demand for labor is positively associated with cropped land but negatively associated with the proportion of area under tenancy. The wage rate, measured at the village level, affects the demand for labor. The coefficient of the variable is statistically significant at less than 1 percent probability of error. The value of the coefficient evaluated at the mean level of the variable gives a wage elasticity of demand for labor at −0.58. The coefficient of the technology variable suggests that technological progress would increase the demand for labor significantly. The estimated t-value of the regression is extremely high. The value of the coefficient indicates that an increase in area under the new technology by 1 acre would increase the demand for hired labor in crop production by about 28 days.

The labor demand function has also been estimated with the alternative specification of the wage rate at the household level. The results are the following:

$$\begin{array}{llllll} \text{DLBR} & = & 73.19 & +\ 8.70\,\text{LAND} & -\ 1.59\,\text{WRKR} & +\ 28.06\,\text{TECH} \\ & & (4.80) & (10.78) & (-0.56) & (13.48) \\ & - & 0.48\,\text{TNC} & -\ 2.53\,\text{HWAGE}; & & \\ & & (-4.08) & (-3.55) & & \end{array} \tag{14}$$

$\bar{R}^2 = 0.51$, $F = 97.4$, $N = 408$,

where HWAGE is the wage rate in taka per day paid by the household and other variables, as defined earlier. The results are similar except that the value of the coefficient for the wage rate increases and its statistical significance improves. The wage elasticity of demand for labor at this value is estimated at −0.65.

Impact of Technology on the Wage Rate

As mentioned earlier, the survey did not collect information on in-migration of labor from outside the sample or on demand for labor in nonfarm activities, so it is not possible to balance the supply and demand for labor in order to estimate a simultaneous equation system for determination of the wage rate.

The single equation estimates of the supply and demand for agricultural labor, however, indicate that technological progress may significantly affect the wage rate. It generates opportunities for additional self-employment in agriculture, thus reducing the supply of labor in the market by the landowning households. On the other hand, it increases the demand for farm labor in the market, so a gap develops between the demand for and supply of labor by the landowning households in the technologically developed villages. The gap may be filled by a supply of more labor from the landless group within the villages or by out-migration of labor from labor-surplus households in villages where the technology has not yet made much progress. In this way, the forces in the labor market may operate to redistribute income from higher- to lower-income groups within the developed villages, and from developed to relatively underdeveloped villages. The results also show that as technology progresses, even the landless in the developed villages supply less labor to the market. This indicates the possibility of considerable in-migration of labor from underdeveloped villages, without which there would be an upward pressure in the wage rate for clearing the labor market.

In order to see the impact of the technology on the wage rate, a wage equation was estimated, incorporating all variables that significantly affect the supply and demand for agricultural labor. After elimination of the statistically insignificant variables, the following wage equation has been obtained:

$$\begin{array}{llllll} \text{VWAGE} & = & 19.32 & -\ 0.26\,\text{LAND} & +\ 1.25\,\text{TECH} & +\ 0.44\,\text{TNC} \\ & & (46.95) & (-4.19) & (10.59) & (2.38) \\ & - & 0.72\,\text{WRKR} & +\ 0.10\,\text{EDCN}; & & \\ & & (-4.10) & (1.71) & & \end{array} \tag{15}$$

$\bar{R}^2 = 0.22$, $F = 26.1$, $N = 408$.

Figures within parentheses are estimated t-values. If wages are exogenously determined, all variables would be expected to be statistically insignificant. But nearly a fifth of the variation in wage rate across the villages is explained by the above variable. Technology seems to be the most important variable affecting the wage rate. This is also found to be the case when wage rate is measured at the household level, as shown by the following equation:

$$\begin{aligned} \mathrm{HWAGE} &= \underset{(51.12)}{19.50} - \underset{(-3.56)}{0.23}\,\mathrm{LAND} + \underset{(9.84)}{1.24}\,\mathrm{TECH} \\ &\quad - \underset{(-3.72)}{0.68}\,\mathrm{WRKR} + \underset{(2.01)}{0.39}\,\mathrm{TNC}; \qquad (16) \end{aligned}$$

$\bar{R}^2 = 0.18, \quad F = 26.5, \quad N = 408.$

Conclusions

Modern technology affects the labor market mainly through the income variable. At higher levels of income, households substitute leisure for labor and supply less labor in the market. This redistributes employment from higher- to lower-income groups. Even the poor supply less labor in the market as income increases with technological progress. But the demand for agricultural labor goes up because of the higher labor intensity of MVs, thus putting an upward pressure on the wage rate and increasing wage earnings from the same amount of labor. These forces in the labor market may also operate, by promoting rural-rural migration, to redistribute some employment and income from technologically developed to underdeveloped villages. Unfortunately, the survey did not collect any information on migration, so a direct testing of the hypothesis is not possible.

8

LINKAGE EFFECTS OF AGRICULTURAL GROWTH

It was shown in Chapter 4 that diffusion of the new technology would substantially increase the income from crop production. The crop sector accounts for about 77 percent of agricultural income in the country. Thus technological progress is expected to have a significant effect on the growth of agricultural income.

Agricultural growth involves linkages to nonfarm sectors, and the poor may gain indirectly through the generation of employment in these activities.[101] The linkages may be generated from the supply side through investment of the new surpluses by the landowners, or from the demand side through income-induced expenditure on nonfarm goods and services, or from both. The growth of agricultural income may also increase the opportunity for investment and employment in nonfarm rural activities through its effects on the demand for such items as (1) irrigation equipment and other modern agricultural inputs produced in the nonagricultural sector, (2) services for processing and marketing additional surplus produce, and (3) trade and transport services arising from the additional purchase of nonfarm products.

Empirical studies for a number of developing countries show that the linkage effects of agricultural growth can be substantial.[102] Bell, Hazell, and Slade concluded from a study of the Muda irrigation project in Malaysia that for each dollar of agricultural income created directly by the project, an additional 80 cents of value added was created indirectly in the local nonfarm sector. In a study of interrelationships between agricultural and industrial growth performance in India, Rangarajan found that a 1.0 percent addition to the agricultural growth induced a 0.5 percent incremental growth of industrial output and 0.7 percent additional growth of national income. Recognizing the importance of such expenditure-induced growth linkages, Mellor argued that, contrary to conventional wisdom, agriculture can play the role of the leading sector in the development process.[103]

This chapter attempts to assess the nature and extent of such linkage effects by analyzing the expenditure pattern of the sample households in the technologically developed and underdeveloped villages. The data on expenditures were collected from two types of interviews. Information on daily necessities was collected on a weekly basis by asking households about consumption and purchases of these items for the week preceding the interview. This survey was conducted 8 times in 1982 during busy, normal, and slack seasons of economic activity in the sample villages. The expenditure on these items for the whole year was then estimated on the basis of the eight weeks' data. The information on expenditures on major items, such as clothing, household effects, education, recreation, health, and acquisition and repair of fixed assets, was collected four times during the year, retrospectively on a quarterly basis.

---

[101] Mellor, *The New Economics of Growth.*

[102] Clive Bell, Peter Hazell, and Roger Slade, *Project Evaluation in Regional Perspective* (Baltimore and London: Johns Hopkins University Press, 1982); C. Rangarajan, *Agricultural Growth and Industrial Performance in India,* Research Report 33 (Washington, D.C.: International Food Policy Research Institute, 1982).

[103] Mellor, *The New Economics of Growth.*

Expansion of the Market: An Analysis of Consumption Patterns

Methodology

The commodities and services consumed have been classified into the following groups for study of the consumption-induced linkages:

Crops:	Rice, wheat, other grains, roots, vegetables, pulses, fruits, spices, betel nuts and betel leaves, rice husks, jute sticks
Forestry:	Firewood, leaves
Livestock:	Meat, milk, eggs, cow dung
Fishery:	Raw and dried fish
Rural processing:	Gur (raw sugar), bidi (indigenous cigarettes), tobacco, mustard oil, sweets, handloom clothes, tailoring
Urban processing:	Sugar, tea, cigarettes, soybean oil, coconut oil, kerosene, electricity, matches, soap, soda, toiletries, mill-made clothing, ready-made garments, imported new and old clothes, shoes
Services:	Education, health, transport, personal services, social services, religious services.

The impact of the growth of income on demand for the various goods and services has been studied by estimating an Engel function of the following type on the cross-section data:[104]

$$E_i = \alpha_i + \beta_i E + Y_i E \log E + \mu_i \log F + \lambda_i E \log F, \qquad (17)$$

where E is the per capita expenditure of the household, E_i is the amount of expenditure incurred on the consumption of goods in the ith group, and F is the number of persons in the household. This is a nonlinear function that allows for variation in the marginal budget share for the ith group, MBS_i, at different levels of income, which can be derived as follows:

$$MBS_i = \beta_i + Y_i(1 + \log E) + \lambda_i \log F \qquad (18)$$

The size of the family would have an important bearing on the economic position of the household at a given level of income, so it has been included in the equation as an important socioeconomic variable influencing consumption behavior of the household.

---

[104] For details of this form of the Engel function and its characteristics, see Hazell and Roell, *Rural Growth Linkages*. pp. 22-24.

To avoid the problem of heteroscedasticity, that the variability in the E_i increases with the explanatory variable E, the function has been fitted in the following expenditure-share form, which is derived from equation (18).

$$S_i = \beta_i + \alpha_i/E + Y_i \log E + \mu_i \log F/E + \lambda_i \log F, \qquad (19)$$

where $S_i = E_i/E$ is the share of the expenditure. The disadvantage of estimating the share equation is that the value of $\bar{R}^2$ is typically small,[105] but it ensures the desirable property that the sum of the marginal budget share is equal to unity.[106]

Since per capita income is a better measure of the economic standing of the household than is household income, the expenditure variable has been measured in per capita terms. But the household size has been included so that the model permits this variable to influence both the intercept and the slope of the individual Engel functions.

Discussion of Results

The estimated parameters for the Engel function are reported in Table 57. As the function is estimated in the expenditure-share form, the value of $\bar{R}^2$ is, in general, low.

Table 57—Estimates of Engel function for rural households, 1982

Commodity Group	Estimated Values of the Parameter					$\bar{R}^2$
	α	β	Y	μ	λ	
Crops	−230.00 (4.73)	2.779 (18.15)	−0.2575 (−14.86)	−2.251 (−0.64)	−0.0017 (−0.99)	0.44
Forestry	23.70 (1.43)	0.031 (0.60)	−0.0012 (0.20)	−0.650 (0.54)	−0.0021 (−3.53)	0.08
Livestock	−0.38 (−0.02)	−0.116 (−2.39)	0.0195 (3.54)	1.286 (1.157)	0.0004 (0.76)	0.08
Fishery	−40.90 (−3.53)	0.061 (1.68)	−0.0007 (−0.02)	2.660 (3.18)	−0.0016 (−3.93)	0.09
Rural processing	92.80 (3.79)	−0.342 (−4.44)	0.0502 (5.76)	−3.010 (−1.71)	0.0020 (2.25)	0.06
Urban processing	39.90 (1.41)	−0.409 (−4.61)	0.0596 (5.92)	1.530 (0.75)	−0.0005 (−0.49)	0.12
Services	114.70 (3.29)	−0.990 (−9.03)	0.1255 (10.10)	0.380 (0.15)	0.0033 (2.64)	0.28

Source: Estimates based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Notes: The function was estimated in the following form:

$$S_i = \beta_i + \alpha_i/E + Y_i \log E + \mu_i F/E + \lambda_i F,$$

where S_i is the share of the commodity group in total consumption expenditure, E is the per capita consumption expenditure, and F is the number of persons in the household. Figures in parentheses are estimated t-values.

---

[105] The value of $\bar{R}^2$ for this equation measures the extent to which the variation of the average budget share of the commodity across the sample is explained by the variation in income. If the marginal budget share is equal to the average share, that is, the expenditure elasticity of demand is unity, the average budget share would be the same across the income level and the value of $\bar{R}^2$ would be zero.

[106] S. J. Press and H. S. Houthakker, *The Analysis of Family Budgets* (Cambridge: Cambridge University Press, 1971), pp. 55-56.

For forestry, livestock, fishery, and rural processing, the value of $\bar{R}^2$is less than 0.10, indicating that the share of these commodities in total expenditure does not vary much with the level of income, which suggests that the expenditure elasticity of demand is close to unity. But the value $\bar{R}^2$ is relatively high for crop-sector outputs and services, which indicates that the expenditure elasticity of demand for them deviates significantly from unity. The value of the coefficient, Y, shows what happens to the marginal budget share as the level of income changes. The estimated value of this variable is significantly negative for crop-sector output, which shows that the incremental expenditure on these commodities declines with increases in income. The value is significantly positive for livestock, manufactured goods, and services.

The estimates of marginal budget share and the expenditure elasticity of demand derived from the parameters of the Engel function are reported in Table 58. About two-thirds of the expenditure is allocated to commodities produced in the crop and forestry sectors, where the share of land in value added is very high. But the marginal budget share for these commodities is 53 percent, which suggests that with increases in income, people spent proportionately much less on these items. The expenditure elasticity of demand is estimated at 0.77 for crops and 0.79 for forestry products.[107] Among agricultural commodities, livestock and fishery products have elastic demand; the marginal share of these products is 11 percent, while the average share is 8 percent. Manufactured goods have a share of 17 percent of the total budget; nearly 56 percent of these goods are produced in rural areas. These commodities also have elastic demand; the share of them in the incremental expenditure is nearly 23 percent. The expenditure is, however, more elastic for goods produced in urban areas.[108] With increased income, the marginal share of manufactured goods of rural origin increases less than proportionately.

But the highest elasticity of demand is for rural service-sector activities, in which labor's share of income is very high. Nearly 13 percent of the enlarged market for

Table 58—Estimates of marginal budget shares and expenditure elasticity of demand, 1982

Commodity Group	Average Budget Share	Marginal Budget Share	Expenditure Elasticity of Demand
	(percent)		
Crops	64.94	50.26	0.77
Forestry	3.59	2.82	0.79
Livestock	4.22	5.80	1.38
Fishery	3.95	5.01	1.27
Rural processing	9.51	11.22	1.18
Urban processing	7.51	11.21	1.49
Services	6.21	13.46	2.17

Source: Estimated from Table 57.

---

[107] Not all commodities in this group have expenditure elasticity less than unity. Pulses and fruits have highly elastic demand, but their share of the budget was less than 4 percent. See Appendix, Table 73.

[108] The manufactured goods that have elastic demand are bidi (cigarettes), tobacco, kerosene, washing soda, and old readymade garments that are imported from abroad for the poor. As incomes increase, cigarettes are substituted for bidi and tobacco, soaps for washing soda, and electricity for kerosene in areas of developed infrastructure. The other substitute commodities are gur (raw sugar) and sugar; gur is produced in villages. While the expenditure elasticity of gur is lower than that of sugar, it is still higher than unity. See Appendix, Table 73.

goods and services goes to service activities. The expenditure elasticity is estimated at about 2.2, indicating that with a 10 percent increase in total expenditure, the demand for service-sector activities would increase by about 22 percent. All nonfarm goods and services together share about 47 percent of the incremental expenditure and have elasticity of 1.5.

To assess the impact of technological progress on the demand for various types of commodities, the Engel function has been estimated separately for the technologically developed and underdeveloped villages. The estimates of demand derived from the parameters for the two groups of villages are reported in Table 59. It will be noted from the results that for both groups of villages the pattern of expenditure is almost the same as that obtained earlier for the entire sample. Crops and forestry products have inelastic demand, while services and urban manufactured products have the most elastic demand. With technological progress, the difference becomes even more pronounced because of the increase in income. The per capita income in developed villages was 22 percent higher than in underdeveloped ones (see Chapter 9). In the underdeveloped villages, 42 percent of the incremental expenditure was for cereals, but in the developed villages the share was 31 percent. The expenditure elasticity of demand for cereal is 0.64 in the developed villages, compared with 0.79 in the underdeveloped villages. Roots and vegetables have inelastic demand; their marginal budget share and the value of elasticity are lower in the developed villages. Pulses have highly elastic

Table 59—Expenditure pattern of households in developed and underdeveloped villages, 1982

Commodity Group	Underdeveloped Villages			Developed Villages		
	Average Share	Marginal Share	Expenditure Elasticity	Average Share	Marginal Share	Expenditure Elasticity
	(percent)			(percent)		
Crops	67.0	56.5	0.84	62.9	45.0	0.71
Cereals	53.0	42.1	0.79	49.1	31.2	0.64
Pulses	1.1	1.3	1.24	0.8	1.2	1.56
Roots and vegetables	5.4	4.7	0.87	4.8	3.1	0.65
Fruits	2.1	3.4	1.62	1.9	3.0	1.57
Spices	3.4	2.9	0.84	3.7	3.3	0.91
Betel nuts and betel leaves	0.9	1.4	1.55	1.3	1.3	1.00
Rice husks and jute sticks	1.0	0.7	0.70	1.3	1.7	1.30
Forestry	4.1	3.2	0.78	3.1	2.7	0.88
Firewood	2.0	2.6	1.29	1.5	2.1	1.38
Leaves	2.1	0.6	0.30	1.6	0.7	0.43
Livestock	4.4	5.7	1.29	4.0	6.4	1.59
Meat and eggs	1.6	3.2	2.00	2.1	4.4	2.10
Milk	0.9	1.8	1.93	1.3	2.4	1.92
Cow dung	1.9	0.6	0.33	0.7	−0.4	−0.58
Fishery	3.6	4.2	1.19	4.4	5.3	1.22
Manufactures	16.7	22.9	1.37	17.5	22.7	1.29
Rural origin	9.5	12.4	1.30	9.5	10.3	1.09
Urban origin	7.2	10.5	1.46	7.8	12.4	1.56
Services	4.2	7.5	1.79	8.2	17.9	2.18

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Notes: Figures are derived from commodity-specific Engel functions estimated from household-level data. Parts may not add to totals because of rounding.

demand but their average and marginal consumption are lower in developed villages, presumably because of reallocation of land from pulses to MV rice. Among food items, meat, eggs, and milk have expenditure elasticities of 2.0 and their share of the marginal budget is 6.8 percent in developed villages, compared with 5.0 percent in underdeveloped villages. The most significant difference in the marginal budget share is found for service-sector activities. In the underdeveloped villages only 7.5 percent of the incremental expenditure was for these items; in the developed villages, the share was about 18 percent. Only for rural manufacturing is the value of the expenditure elasticity lower in the developed villages, but the absolute value is still greater than unity. The above findings indicate that the market for livestock and fishery products, manufacturing, and services expands more than proportionately as technological progress increases rural income. The most significant effect is on service activities, where labor's share of income is high compared with other commodity groups.

Reinvestment of Surplus

Investment defined as additions to the value of fixed assets and working capital is classified here into two broad groups—directly productive investment and other investment. Investments in agricultural and nonagricultural enterprises are regarded as directly productive investment. Agricultural investment includes expenditures on land development (such as leveling land, fencing, clearing water hyacinths, raising small embankments in fields for improved water control, and digging field channels for irrigation); purchase of agricultural machinery and tools, equipment, and draft animals; purchase of cattle and poultry for rearing; and expenditures on pond digging and tree planting. Nonagricultural investment includes purchases of industrial machinery and tools, transport equipment, and shares and debentures, and additions to fixed and working capital for trade and business. Changes in the stock of output and raw materials for agriculture and industry could not be taken into account due to lack of information. Nonmonetary investment in the form of use of family labor has been imputed by the prevailing market wage rate.

The second group, other investment, includes expenditures on construction and improvement of housing and cattle sheds, education of children, digging of wells and tubewells for drinking purposes, and construction of latrines. These may be termed social investments for formation of human capital, which may increase the productivity of labor in the long run. Expenditures on household durables, such as furniture and fixtures, electrical goods, and metal and earthen utensils, have also been treated as investment.

A significant number of households have been engaged in transactions that may be called transfers. These include such items as purchase and sale of land, receipt and repayment of loans and interest, expenses on account of litigation, and theft of property. At the aggregate level the net transfers should be zero. For the sample under study, however, the net transfer was found to be significantly positive, indicating the possibility of an underreporting of negative transfers, which people tend to suppress. Because of the conceptual problems involved, these items have not been included in investment.

The pattern of investment in the technologically developed and underdeveloped villages can be reviewed in Table 60. Total investment per household was almost the same for the two groups, but because of higher levels of expenditure, the rate of investment was lower in the developed villages (14 percent) than in the underdeveloped villages (17 percent). The difference is mainly on account of the directly productive investments, which accounted for 11.7 percent of the total expenditure in under-

Table 60—Pattern of investment in technologically developed and underdeveloped villages, 1982

Type of Investment	Amount per Household		As Share of Gross Investment		As Share of Total Expenditure	
	Underdeveloped Villages	Developed Villages	Underdeveloped Villages	Developed Villages	Underdeveloped Villages	Developed Villages
	(Tk)		(percent)			
Directly productive investment						
Agriculture	1,039	881	32.9	28.2	5.6	3.9
Land development	106	135	3.4	4.3	0.6	0.6
Agricultural tools and equipment	408	75	12.9	2.4	2.2	0.3
Draft animals and livestock	494	645	15.6	20.6	2.6	2.9
Other agriculture	31	26	1.0	0.8	0.2	0.1
Nonagriculture	1,132	769	35.9	24.6	6.1	3.4
Industry	225	29	7.1	0.9	1.2	0.1
Business	874	711	27.7	22.7	4.7	3.1
Transport	33	29	1.1	1.0	0.2	0.1
Other investment	986	1,477	31.2	47.2	5.3	6.5
Housing	727	1,186	23.0	37.9	3.9	5.3
Sanitation	27	29	0.9	0.9	0.1	0.1
Consumer durables	232	262	7.3	8.4	1.3	1.2
Total investment	3,157	3,127	100.0	100.0	16.9	13.9
Total expenditure (consumption plus investment)	18,640	22,600	. . .	. . .	100.0	100.0

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

developed villages, compared with only 7.3 percent in the developed villages. Two items on which households in developed villages spent proportionately more are construction of housing and acquisition of livestock. But the rate of investment in agricultural equipment and tools, cottage industry, and business was significantly higher in the underdeveloped villages.

Table 61 shows the pattern of investment for different landownership groups. As expected, the rate of investment is positively associated with the size of landownership. For the landless and small landowning households, the rate of investment was almost the same in the technologically developed and underdeveloped villages. But the medium and large landowners in the developed villages accumulated proportionately much less than their counterparts in the underdeveloped villages. It is interesting to note that the large landowners invested relatively less for capital formation in agriculture than did the small and medium landowners. A similar finding was reported by Rahman from a survey of two areas in 1975.[109]

Capital formation in nonagricultural activities was significantly higher in the technologically underdeveloped villages. Since the scope for accumulation of land is limited in these villages, rural households try to increase income through accumulation in nonagriculture, as the market for nonfarm goods and services expands with technological

---

[109] Atiq Rahman, "Surplus Utilisation and Capital Formation in Bangladesh Agriculture," *The Bangladesh Development Studies* 8 (No. 4, 1980): 21-46.

Table 61—Pattern of investment for different landownership groups, 1982

	Directly Productive Investment		Other Investment		
Landownership Group[a]	Agriculture	Nonagriculture	Housing and Sanitation	Consumer Durables	Total
	(percent of household expenditure)				
Underdeveloped villages					
Marginal	2.3	3.8	1.7	0.7	8.5
Small	5.4	2.1	3.5	2.0	13.0
Medium	7.1	5.3	5.2	1.0	18.6
Large	5.8	14.3	4.9	2.0	26.3
Developed villages					
Marginal	1.2	2.2	4.0	1.1	8.4
Small	6.2	1.6	3.6	1.1	12.6
Medium	3.6	6.0	4.2	1.1	14.9
Large	3.5	2.7	10.4	1.4	18.0

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Marginal, less than 0.5 acre; small, 0.5-2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

progress. But this opportunity is taken up more by the upper-income households. In the underdeveloped villages, nonagricultural investment as a proportion of total expenditure is about 14 percent for the large landowning households, compared with 2-5 percent for the other landholding groups.

The information presented in this section thus leads to the following main conclusions. First, technological progress does not necessarily lead to higher capital formation in agriculture. The reason for this may be that investment in irrigation, which is the main vehicle of technological progress, is made by the government. Second, expansion of the market for nonfarm goods and services seems to stimulate the most nonagricultural investment in villages where technology has made the least progress. This may occur because the new technology provides an opportunity for increasing income from the land for households in the developed villages. Since such an opportunity is lacking in the underdeveloped villages, those households look for opportunities in the nonfarm sector to increase their incomes. Third, income from investment-induced linkages tends to be unequally distributed. Because of the higher levels of income, accumulated savings, and better access to financial institutions, the large landowners can respond more readily to opportunities of investment in the nonfarm sector than can the landless and small landowners, although the latter may gain from creation of additional employment in these activities.

Impact on the Land Market

A factor to which much emphasis has been given in the literature[110] to explain the negative income-distribution effects of modern technology is the impact of agricultural surplus on the rural land market. By increasing the profitability of cultivation, the new technology inflates the surplus of the large landowners and increases the value of land. On the other hand, it makes cultivation difficult for the marginal landowners, since the working capital requirement for cultivation of the new varieties is substantially higher, and the poor have little access to credit from financial institutions. It is argued that with technological progress these forces will operate to increase transactions in the rural land market, and the large landowners will buy out the marginal farms, leading to further accumulation of land by the rich and a higher concentration of income.

---

[110] See, for example, Pears, *Seeds of Plenty.*

The survey collected information on the source of acquisition of each plot of land owned by the sample households. This information can be used to empirically test the above hypothesis. If technological diffusion is associated with high transactions in the land market, the proportion of land obtained through the market would be higher for households in the technologically developed villages than for those in the underdeveloped villages. The findings reported in Table 62 tend to support the hypothesis. In developed villages, 63 percent of total land owned at the time of the survey was inherited from parents, compared with 72 percent for households in the underdeveloped villages, which suggests that the households in developed villages had been engaged in land transactions after inheritance much more than those in underdeveloped villages. The proportion of land acquired through purchase was reported at 32 percent for the developed villages and 25 percent for the underdeveloped villages.

A more direct test of the hypothesis could be made with information on land purchases and sales during the year of the survey. An important limitation on this information is that investment in land is a large, indivisible expenditure, and the household may have to save for a number of years to buy a piece of land, so it is difficult to get a representative picture of the behavior of an individual household from information for one year. A representative picture may be obtained by looking at mean values for a large number of households in a homogeneous group that would incur such expenditures every year.

The proportion of households that participated in the land market in 1982, and the extent of transactions involved, can be reviewed in Table 63, which shows the following major points. The land market is very thin. Less than 10 percent of the households participated in the market during the survey year and the maximum amount of transactions (land sold or purchased) was less than 2 percent of the amount of land. The net transaction was positive in the developed villages and negative in the underdeveloped villages. The accumulation of land in the developed villages was partly at

Table 62—Sources of landholdings in technologically developed and underdeveloped villages, from inheritance to 1982

Source of Owned Land	Underdeveloped Villages: Land Owned per Household	Underdeveloped Villages: Share of Total Land	Developed Villages: Land Owned per Household	Developed Villages: Share of Total Land
	(decimals)	(percent)	(decimals)	(percent)
Inheritance from parents	162	72.0	142	62.8
Inheritance from in-laws	3	1.3	7	3.1
Purchased	57	25.3	72	31.9
Other	3	1.3	5	2.2
Total	225	100.0	226	100.0

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Notes: A decimal is 1/100 of an acre. Parts may not add to totals because of rounding.

Table 63—Transactions in the land market in technologically developed and underdeveloped villages, 1982

Landownership Group[a]	Amount Transacted: As Share of Households: Purchased Land	Amount Transacted: As Share of Households: Sold Land	Amount Transacted: As Share of Owned Land: Purchased Land	Amount Transacted: As Share of Owned Land: Sold Land	Net Accumulation as Share of Owned Land
			(percent)		
Underdeveloped villages	8.8	8.2	1.11	1.79	−0.68
Marginal and small	4.9	8.8	2.05	4.98	−2.93
Medium	13.6	4.9	0.92	0.70	0.22
Large	22.6	2.9	0.85	1.31	−0.46
Developed villages	9.8	8.8	1.73	1.30	0.43
Marginal and small	5.0	7.0	1.32	2.18	−0.86
Medium	16.3	13.8	1.47	2.09	−0.62
Large	21.6	8.1	2.03	0.30	1.73

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Marginal, less than 0.5 acre; small, 0.5-2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

the expense of the small landowners. For the small farmer group, the proportion of land sold was much less in the developed villages than in the underdeveloped ones, which suggests that by increasing income per unit of land, technological progress reduces the necessity to sell land. The highest accumulation, however, was by the large landowning groups in the developed villages. They increased the size of landownership by 1.7 percent during the survey year.

The results seem to support the hypothesis of the negative effect of technological progress on income distribution through accumulation of land. The impact, however, is very small. During 1982, the households in the developed villages accumulated only 0.4 percent of the holdings. At the rate of accumulation (1.7 percent a year), even the large landowners would need 13 years to increase the size of large holdings by only a quarter. On the other hand, without technological progress the small and marginal landholdings would get smaller at a faster rate because of the distress sales of land by the poor.

Conclusions

The increase in agricultural income significantly expands the market for nonfarm goods and services, many of which are located in rural areas. The incremental budget share of these commodities is 52 percent for the technologically developed villages and 40 percent for the underdeveloped villages. The expansion of the market for cottage industry products and services, which are located mostly in rural areas, ia also proportionately greater than that of increases in income. Thus rural households may indirectly gain from employment generated in these activities. But the income growth does not promote capital accumulation in agriculture, presumably because the investment in irrigation, which is the main vehicle for technological progress, is made by the government. The opportunity for additional investment in nonagriculture is taken mainly by the higher-income groups in the technologically underdeveloped villages. Technological progress seems to follow more investment in the formation of human capital and more accumulation of land by large landowners in the developed villages. This suggests that unless the higher-income groups are induced to invest in production activities, or their surplus is siphoned off for acceleration of public investment, diffusion of the new technology may lead to further inequality in the distribution of landholding and agricultural incomes, both regionally and across income scales.

9

EFFECT ON INCOME DISTRIBUTION AND POVERTY

The impact of the differential rate of adoption of the new technology among farmers, the prices of products and inputs faced by them, and the effect of the technology on production, employment, and expansion of the market for nonfarm goods and services will ultimately bring about a change in the level and distribution of rural incomes. This chapter attempts to assess the impact from direct information on household incomes.

Since rural households do not keep records of their activities, it is difficult to estimate income accurately, particularly for activities conducted on a self-employed basis. Most rural households are also involved in many expenditure-saving activities such as producing fruits and vegetables in kitchen gardens, rearing poultry, fishing from nearby creeks and canals, processing food, and manufacturing personal and household effects, basically for family consumption. There is a tendency to underreport these activities, since the respondents do not generally consider them as sources of income.

In this survey, information has been collected as comprehensively as possible for estimating income. A detailed questionnaire on inputs and outputs for crop-production activities was administered three times during the survey year, at the end of each cropping season, to reduce errors attributable to faulty memory. Input-output information on processing, manufacturing, and trading activities was collected through quarterly surveys. The wage income and irregular expenditure-saving activities were recorded in a weekly consumption, expenditure, and employment survey that was administered eight times during the year. The annual incomes from these sources have been estimated by extrapolating from the estimates for the eight weeks.

Level and Structure of Income

The estimates of income obtained from the survey for households in technologically developed and underdeveloped villages can be reviewed in Table 64. For the entire sample, the average household income in 1982 is estimated at Tk 21,000 and per capita income at Tk 3,304. The latest national hosuehold expenditure survey conducted by the Bangladesh Bureau of Statistics estimates the per capita rural income for 1983/84 at Tk 3,883. At 1982 prices this yields Tk 3,347, which is very close to our estimate. The 1981/82 household expenditure survey, however, shows that the estimated rural per capita income was less than our estimate for 1982. This may be due to the selection of a larger proportion of the technologically developed area in our sample than in the country. In Bangladesh, 24 percent of the cropped area and 28 percent of the cereal area was under MVs during 1982/83. In our sample, the proportions were 37 and 46 percent, respectively.

The total household income was 29 percent higher in the technologically developed villages than in the underdeveloped villages, indicating a positive effect of the technology on the level of income. The number of persons per household is also higher in the developed area, so the difference in per capita income is less—about 22 percent. Compared with underdeveloped villages, the average size of the family in the developed villages was about 13 percent higher for the landless group but only 3 percent higher

Table 64—Structure of household incomes in technologically developed and underdeveloped villages, 1982

Sources of Income	Underdeveloped Villages		Developed Villages		Increase in Income in Developed Villages Over That in Underdeveloped Villages
	Annual Household Income	Share of Source	Annual Household Income	Share of Source	
	(Tk)	(percent)	(Tk)	(percent)	(percent)
Agriculture	11,178	61.0	15,644	66.2	40.0
Crop cultivation	6,258	34.1	9,265	39.2	48.1
Kitchen gardening	2,465	13.5	2,730	11.5	10.8
Livestock and poultry raising	1,272	6.9	1,511	6.4	18.8
Fishing	287	1.6	1,099	4.6	283.0
Agricultural wages	896	4.9	1,039	4.4	16.0
Nonagriculture	7,151	39.0	7,994	33.8	11.8
Cottage industry	726	4.0	268	1.1	–63.1
Trade	886	4.8	1,889	8.0	113.2
Services	3,268	17.8	4,417	18.7	35.2
Nonagricultural wages	2,271	12.4	1,420	6.0	–37.5
Total household income	18,329	100.0	23,638	100.0	29.0
Per capita income	2,961	. . .	3,626	. . .	22.4

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Note: The average household size was 6.52 in developed villages and 6.19 in underdeveloped villages, a difference of 5.3 percent.

for other groups. This may be the result of a reduction in mortality rates following the increases in income in very poor households.

As expected, the new technology has a more pronounced effect on agricultural incomes than on nonagricultural incomes. Nearly 61 percent of household income in underdeveloped villages originates from the agricultural sector, 52 percent from crop and vegetable production, and 9 percent from livestock and fishing. In developed villages, the crop sector income (including agricultural wages) was 44 percent higher, and total agricultural income was 40 percent higher than in underdeveloped villages. The increase in agricultural income was 48 percent for crop cultivation, and 16 percent for agricultural wages. The absolute level of nonagricultural income was also higher in the developed villages, but the difference is substantially less than for agricultural income. The income from trade and other services was about 52 percent higher in the developed villages, but the income from cottage industry and nonagricultural wages was lower by about 44 percent, which pushed down the income difference from nonagricultural sources between these two groups of households. Many cottage industries are low-productivity activities, and a part of the nonagricultural wages is earned from domestic service and earthwork—the jobs that are least preferred at higher levels of income. As argued in the chapter on employment, the stimulus from agricultural growth for these activities appears to be taken by households in underdeveloped villages and by lower-income groups.

Table 65 measures the income effect for different landownership groups by comparing the estimates for the developed and underdeveloped villages. It is found that among farming households the positive income difference for developed villages is higher for the large landowning groups—34 percent for the large landowner compared with 22 percent for the small and 28 percent for the medium owner, which suggests a trend

Table 65—Estimates of household income in developed and underdeveloped villages, 1982

Income/Landownership Group[a]	Underdeveloped Villages	Developed Villages	Difference in Developed Villages Over Underdeveloped Villages
	(Tk/household)		(percent)
Agricultural income			
Landless and marginal	3,708	8,000	116
	(3,549)	(6,151)	(73)
Small	9,201	11,234	22
Medium	16,190	20,685	28
Large	29,437	39,435	34
Nonagricultural income			
Landless and marginal	6,036	6,264	4
Small	6,819	7,071	4
Medium	8,119	7,618	–6
Large	9,372	16,721	78
Total income			
Landless and marginal	9,743	14,264	46
	(9,585)	(12,415)	(30)
Small	16,020	18,305	14
Medium	24,309	28,303	16
Large	38,809	56,156	45

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Note: Figures within parentheses are household incomes for the group, excluding the income from fishing. One of the villages under study has a high concentration of commercial fishermen, most of whom belong to the landless and marginal landowner group. This village is included in the developed area, so the high income of the landless from fishing in the developed villages may show a spuriously high positive impact of the new technology on the income for this group.

[a] Landless and marginal, less than 0.5 acre; small, 0.5-2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

toward inequality in the distribution of income among farm households. But the group that has gained the most is the functionally landless, the bottom one-third of the rural households on the landownership scale. For this group, the income from agricultural sources is more than double in the developed villages over the underdeveloped villages. Further disaggregation of results for this group shows that a major source of the difference in income is due to fishing. Commercial fishing in Bangladesh is highly localized and in the sample it was concentrated in one village where land per person is extremely low, but where a large proportion of land is irrigated and cultivated with high-yielding varieties. The poor in this village earn a large proportion of their income from fishing, which cannot be attributed to the new technology. But even if fishing is excluded, agricultural income for the landless was 73 percent higher for the developed villages than for the underdeveloped villages—still higher than the income difference for the large landowning groups. The difference is mostly on account of income from cultivation (204 percent) and agricultural wages (79 percent). The transfer of irrigated land to marginal landowners through the tenancy market for cultivation of the rice MVs was an important mechanism for increasing the income of the poor from cultivation. In the underdeveloped villages a large proportion of marginal landowners rented out their tiny holdings and were dependent on the agricultural labor market and nonfarm activities for their livelihood. Only 32 percent of the sample households that own less than 0.5 acre of land received income from crop cultivation in underdeveloped villages, compared with 58 percent in developed villages. For the farm households in this group, the average income from crop cultivation was 65 percent higher in developed villages than in underdeveloped ones.

The figures in Table 65 show that the income gains from the nonagricultural sources have been confined mostly to the large landowning group. Compared with underdeveloped villages, the income from nonagricultural sources in developed villages is about 78 percent higher for the large landowner but 6 percent lower for the medium landowning group. Because of this unequal distribution of incremental income from nonagricultural sources, the difference in gains for the landless and large landowning groups narrows. For these groups the household income in the developed villages was about 45 percent higher—about three times the gains for the small and medium landowning groups.

The transfer of income to various landholding groups through the operation of the labor market can be assessed from wage earnings from agricultural and nonagricultural labor. The survey estimates of income from this source for the two groups of villages are reported in Table 66. The findings are similar to those reported in Chapter 7 about employment effects of the new technology. The agricultural wage income is inversely related to the size of landholding, and large landowners earn very little from this source. The agricultural wage income is about 16 percent higher in developed villages, but this is exclusively due to the functionally landless group, whose income from this source was about 79 percent higher in the developed villages. With increases in income the landowning group participates less in the agricultural labor market; their income from this source was substantially lower in the developed villages than in the underdeveloped ones. Only for the large landholding group was the wage income from nonagricultural labor higher in developed villages. The smaller landholding group had lower nonagricultural wage earnings in developed villages, indicating that with increases in agricultural income they withdraw some of the labor from the nonagricultural labor market. The income loss from this source was more pronounced for the small and medium landowners than for the landless.

Income Effect of Technology: A Regression Estimate

The previous section assessed the income effect of the modern technology by comparing the estimates of income for households in technologically developed and

Table 66—Incomes earned through the labor market, by technology and landholding groups, 1982

	Agricultural Wage Income			Nonagricultural Wage and Salary Incomes		
Landownership Group[a]	Underdeveloped Villages	Developed Villages	Difference	Underdeveloped Villages	Developed Villages	Difference
	(Tk/household)		(percent)	(Tk/household)		(percent)
Landless and marginal	1,326	2,370	79	2,546	2,163	−15
Small	1,147	753	−34	2,850	1,364	−52
Medium	366	184	−50	1,835	761	−58
Large	31	94	[b]	349	1,000	187
All groups	897	1,039	16	2,271	1,420	−37

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Landless and marginal, less than 0.5 acre; small, 0.5-2.5 acres; medium, 2.5-5.0 acres; large, 5.0 acres or more.

[b] Not estimated because of very small income from wage earning for this group.

underdeveloped areas. A limitation of this approach is that besides technology, a host of other factors determine income, and their effects cannot be dissociated when comparing mean values of the variables for the two groups. A more appropriate method of assessing the income effect of the new technology would be to fit a regression model, relating income to its determinants and incorporating technology as an additional explanatory variable.

The following regression model was fitted to explain household income:

$$\mathrm{INCM} = f(\mathrm{OWNL}, \mathrm{TNC}, \mathrm{CPTL}, \mathrm{WRKR}, \mathrm{EDCN}, \mathrm{DPND}, \mathrm{TECH}, \mathrm{OWNL}^2), \qquad (20)$$

where

INCM = annual income of household (in taka),
OWNL = land owned by household (in acres),
TNC = land rented in by household (in acres),
CPTL = value of nonland fixed assets (in taka),
WRKR = number of family workers,
EDCN = educational level of head of household (completed years of schooling),
DPND = dependency ratio as measured by the number of consumers per worker in household,
TECH = technology at the household level as defined below.

The adoption of the technology at the household level, TECH, has been measured by three alternative specifications of the variable: the amount of land irrigated, LIRGN; the amount of land sown under rice MVs, LMV; and the expenditure on chemical fertilizers (in taka), FERT. Owing to the strong correlation among these three variables, each variable has been entered alternatively in the model to explain agricultural incomes.

The dependency ratio has been included to test the Chayanovian hypothesis that, in a peasant economy, the motive force behind the economic activity is the consumer-worker balance in the family.[111] This balance has already been found to be a significant variable affecting the labor supply of the household.

The square of owned land has been added to allow the marginal return from land to vary with the size of landownership. It has already been observed that crop yield varies inversely with farm size and that larger landowners prefer more leisure, which indicates that the marginal return from land will decline with the increase in the size of landownership.

The estimated values of the parameters of the income equation for total household income, as well as for agricultural and nonagricultural incomes, are reported in Table 67. The model explains about 55 percent of the variation in agricultural income and 52 percent of the variation in total income within the sample households. Land, both owned and rented, number of workers, and use of the new technology are found to be significant determinants of agricultural income. The value of nonland fixed assets

---

[111] Chayanov, *Theory of Peasant Economy.*

Table 67—Determinants of rural household incomes: regression estimates, 1982

	Agricultural Income				
Variable	Equation (1)	Equation (2)	Equation (3)	Nonagricultural Income	Total Income
			(Tk)		
OWNL	... (14.24)	3,244[a] (14.87)	3,387[a] (14.63)	3,486[a] (1.08)	2,003,459[a] (11.26)
(OWNL)^2	−63[a] (7.54)	−43[a] (5.28)	−41[a] (−4.82)	−2.5 (−0.36)	−43[a] (−3.93)
TNC	1,067[a] (3.27)	627[b] (1.90)	708[c] (2.08)	−183 (−0.66)	351 (0.78)
CPTL[d]	0.021 (0.54)	−0.005 (−0.13)	0.015 (0.35)	0.205[a] (6.04)	0.101[a] (2.66)
WRKR	1,313[a] (3.64)	975[a] (2.65)	1,075[a] (2.82)	2,095[a] (6.68)	3,125[a] (6.22)
EDCN	−123 (−1.50)	−113 (−1.37)	−129 (−1.51)	249[a] (3.50)	172[a] (1.52)
DPND	636 (1.41)	799[b] (1.75)	848[b] (1.79)	827[c] (2.13)	1,649[a] (2.65)
LIRGN	2,468[a] (7.87)	...	...	...	...
LMV	...	1,729[a] (7.22)	...	375[b] (1.89)	1,973[a] (6.13)
FERT	...	...	... (3.57)	2.17[a]	...
Constant	1,757 (1.43)	1,978 (1.56)	1,980 (1.53)	256 (0.24)	2,045 (1.20)
$\bar{R}^2$	0.55	0.55	0.53	0.19	0.52

Note: Figures in parentheses are t-values.

[a] This number is significant at the 0.01 level.

[b] This number is significant at the 0.10 level.

[c] This number is significant at the 0.05 level.

[d] Capital is measured as agricultural capital for the agricultural income equation, nonagricultural capital for nonagricultural income, and total capital for total income equation. The sample size consists of 629 households with valid observations for all variables in the equation.

does not significantly contribute to agricultural income. The coefficient of this variable is not statistically significant in either of the agricultural-income equations. The values of the regression coefficient for agricultural income (Table 67, equation 1) indicate that an acre of owned land contributes at the margin Tk 3,200, while one family worker at the margin earns about Tk 1,300 a year. The marginal contribution of rented land is less than one-third that of owned land. This is understandable in view of the stringent conditions of the sharecropping arrangement—the tenant bears all costs of nonland inputs and pays half of the gross produce to the landowner.

The coefficient of all three technology variables in alternative equations for agricultural income is statistically significant at less than 1 percent probability of error. As discussed in Chapters 3 and 6, irrigation, MV seeds, and fertilizers are highly complementary, so the separate effect of each variable is difficult to measure. The value of the regression coefficient of each of the three technology variables thus measures the composite effect of all of them.

The marginal return from an acre of irrigated land is estimated at Tk 5,712 (3,244 + 2,468).[112] Thus, irrigated land and the associated increase in MV area and fertilizer use increase agricultural income at the margin by about 76 percent over that of nonirrigated land. The value of the coefficients of land variables (table equation 2) for agricultural income indicates that an acre of land under MVs increases agricultural income on the margin by about Tk 5,116—about 51 percent higher than the income earned at the margin from land devoted to traditional crop varieties (Tk 3,387). One taka of expenditure on fertilizer seems to increase agricultural income on the margin by Tk 2.17.[113]

The main determinants of nonagricultural income are the number of workers in the family, accumulation of nonagricultural assets, education, and the consumption pressure of the family. The regression coefficients of these variables are statistically significant at less than 5 percent probability of error. However, the explanatory power of the model is weak, as indicated by the low value of $\bar{R}^2$. This suggests that there may be other variables that determine nonagricultural income, or that the estimate of nonagricultural income at the household level involves a large margin of error, or both. Education increases household income mainly through involvement of the worker in the nonagricultural sector. The estimated value of the coefficient suggests that an additional year of schooling increases nonagricultural income on the margin by Tk 250 a year, but the increase is achieved partly at the expense of agricultural income, so its effect on total household income is less. The rate of return on accumulation of nonagricultural capital appears to be 21 percent. The households that cultivate more land with MVs have higher levels of nonagricultural income. This may be the effect of reallocation of family labor from agricultural to nonagricultural activities, which was explained in Chapter 7. The value of this coefficient is statistically significant at less than 10 percent probability of error.

In the estimated equation for total household income, the coefficient of the technology variable is found to be highly statistically significant. The values of the coefficient of the land variable (OWNL and LMV) show that a shift of land from traditional to modern varieties would increase the marginal return from land by about 57 percent. The coefficient of the square term of land is negative and highly statistically significant. It indicates that the marginal income from land declines with increases in the size of landownership. This may be the result of the negative income effect on the supply of labor, as reported in Chapter 7, which operates particularly in the agricultural sector. This finding also supports the hypothesis that when income increases, the forces in the labor market may operate to redistribute some income from upper- to lower-income groups.

---

[112] The equation is fitted in the following form:

$$Y = a_0 + a_1 (x_1 + x_2) + a_2 x_2,$$

where x_1 is the amount of unirrigated land and x_2 is the amount of irrigated land. It can be rewritten in the following form:

$$Y = a_0 + a_1 x_1 + (a_1 + a_2) x_2.$$

Thus a_1 is the coefficient of unirrigated land and $(a_1 + a_2)$ is the coefficient of irrigated land.

[113] The estimate is close to the incremental-benefit cost ratio of fertilizer estimated by the IFDC from the crop-specific fertilizer response functions fitted on the farm survey data for 1979-82. The weighted average value for six rice varieties evaluated at 1984 prices of fertilizer and paddy is 2.5. See Hossain, "Fertilizer Consumption," p. 195.

Distribution of Income

The sample households have been ranked on the basis of per capita income, and the income shares of successive decile groups have been estimated in order to see the pattern of income distribution in the sample. The impact of technological progress on income distribution has been assessed by comparing the income shares of various groups in the technologically developed and underdeveloped villages. The results can be reviewed in Table 68 and also in Figure 5, which shows a Lorenz curve depicting the pattern of income distribution across the landownership scale.

The income distribution is fairly unequal. The bottom 40 percent of the households in the per capita income scale get about 21 percent of the total income, while about 24 percent of the income accrues to the top 10 percent of the households. The pattern of distribution of income in developed villages was found almost the same as that estimated for rural Bangladesh by the national household expenditure survey of 1981-82. The income, however, appears to be more unequally distributed in the technologically developed villages. The income share of the top 10 percent of the household is about 26 percent in the developed villages, compared with 21 percent in the underdeveloped villages. But the position of the bottom 40 percent of the households does not change. Their share of income is 21.2 percent in the developed villages compared with 21.1 percent in the underdeveloped villages. So the middle 40 percent in the income scale (third and fourth quintiles) are squeezed, and their income share declines from 42 to 39 percent.

The degree of inequality in income distribution is often summarized by the Gini concentration coefficient. The estimated values of the coefficients, based on individual household data, are presented in Table 69. The concentration ratio is estimated at 0.39 for household income, but since higher-income households typically have a larger number of persons, the degree of concentration in per capita income is less, at 0.35. Agricultural income is highly unequally distributed; the concentration ratio is estimated at 0.62. This is, however, related mostly to unequal distribution of landownership, since land is the most important asset determining agricultural income. The degree of inequality in the distribution of nonagricultural income is 0.44. Households that have

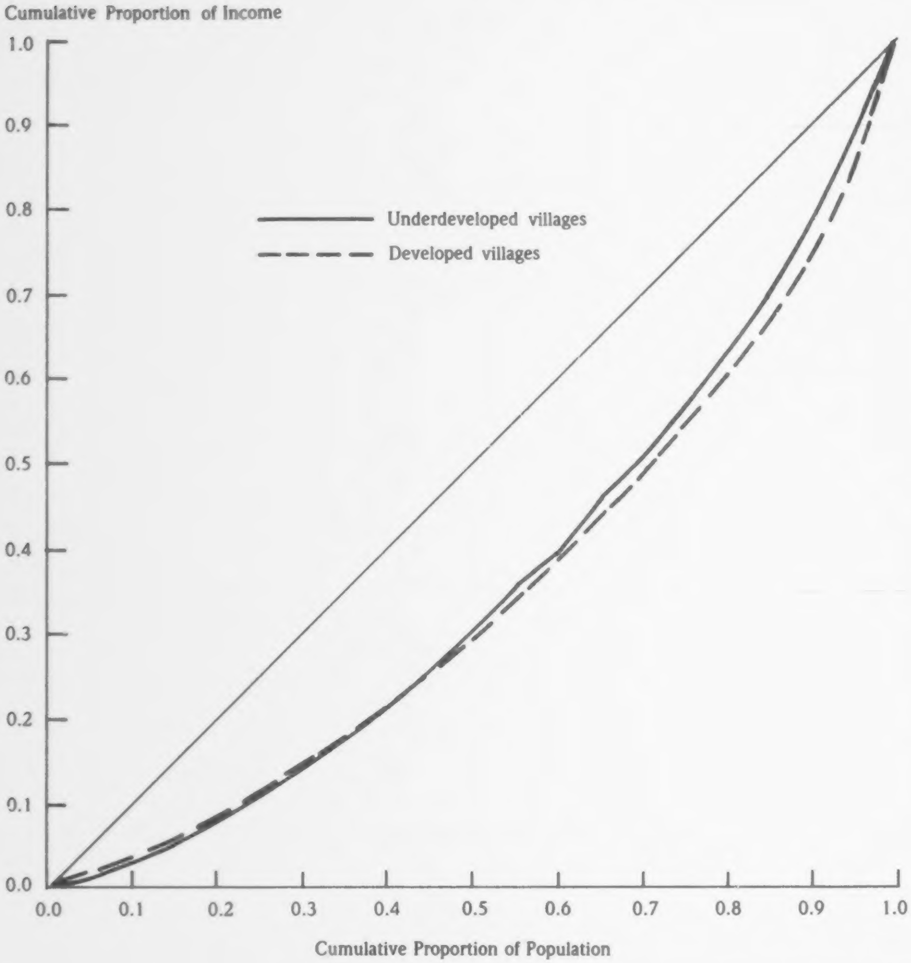
Table 68—Distribution of household income in technologically developed and underdeveloped villages, 1982

Household Ranking by per Capita Income	Income Share of Sample Households, 1982		Rural Bangladesh 1981/82[a]
	Underdeveloped Villages	Developed Villages	
		(percent)	
Bottom 20 percent	7.7	8.0	7.1
Second 20 percent	13.4	13.2	11.7
Third 20 percent	18.4	17.0	16.2
Fourth 20 percent	24.0	21.9	22.6
Top 20 percent	36.5	39.9	42.4
Top 10 percent	21.4	25.8	26.7
Top 5 percent	10.7	15.6	16.8

Source: The figures for rural Bangladesh are from Bangladesh, Bureau of Statistics, *Report of the Bangladesh Household Expenditure Survey, 1981-82* (Dhaka: Ministry of Planning, 1986).

[a] The households have been ranked by total household income.

Figure 5—Lorenz curve showing the pattern of distribution of income in developed and underdeveloped villages along per capita income scale, 1982



less access to land, and hence to agricultural income, tend to compensate by involving themselves more in nonagricultural activities; thus the concentration of household income is lower than that of either agricultural or nonagricultural income.

Technological progress seems to improve the distribution of agricultural income. The concentration ratio is estimated at 0.60 in developed villages, compared with 0.63 in underdeveloped villages, while the concentration in the distribution of landownership is similar. But the distribution of nonagricultural income becomes more skewed, leaving the distribution of total household income unchanged. With increases in income, the family size of the lower-income group increases proportionately more than that of higher-income groups, presumably due to declines in mortality rates, thus making the distribution of per capita income relatively more skewed in the developed villages.

Table 69—Degree of inequality in distribution of income and landholding: Gini ratios for sample households, 1982

Variable	Underdeveloped Villages	Developed Villages	Entire Sample
Land owned	0.61	0.60	0.61
Agricultural income	0.63	0.60	0.62
Nonagricultural income	0.43	0.45	0.44
Household income	0.39	0.38	0.39
Per capita income	0.34	0.36	0.35
Per capita income with adjusted household size[a]	0.33	0.34	0.34

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

[a] Adjusted to adult equivalent consumption unit from age-sex composition of household members.

Alleviation of Poverty

From the welfare point of view, the most appropriate indicator of the effectiveness of a development policy is its effect on the poor. So in recent years there has been a great deal of interest in measuring changes in the incidence of poverty and judging programs and policies on the basis of their effect on the alleviation of poverty.

A conventional way to measure poverty is to establish a poverty line, defined as the threshold level of income needed to satisfy basic minimum food and nonfood requirements, and count the number of people living below that line—the "head-count method" of measuring poverty. For Bangladesh a number of studies have used this method to measure the changes in poverty over time. The usual approach has been to take the normative requirement of different kinds of food (as recommended by the FAO) as the minimum consumption bundle, which gives a per capita intake of 2,100 kilocalories per day, and estimate its cost by applying retail prices for these items. Some adjustment is then made for the requirement of nonfood necessities. Separate poverty lines are estimated for rural and urban areas by taking into account urban-rural differences in price levels. Using this method, the poverty line for rural households was estimated by the author[114] at Tk 1,800 per person for 1978/79. After adjustment for changes in the cost-of-living index for rural areas, the poverty line for 1982 was estimated at Tk 2,392.

Recently the Bangladesh Bureau of Statistics has made alternative estimates of the poverty line for different levels of calorie consumption in the population on the basis of household-level data on income and calorie intake of the population obtained from the 1981/82 national household expenditure survey.[115] To avoid the problems of (1) identification of the minimum needs for different types of food in the consumption basket, and (2) choice of representative items for different consumers, the poverty line was estimated by fitting an equation of per capita income to per capita calorie intake and then determining the income for the threshold calorie intake. For rural households the method yielded a poverty line of Tk 2,304 for a daily intake of 2,200 kilocalories per person, and Tk 1,680 for an intake of 1,800 kilocalories per person for 1981/82. The first may be referred to as the threshold income for moderate poverty and the second for extreme poverty. After adjustment for changes in the rural cost of living, the lines are estimated for 1982 at Tk 2,374 and Tk 1,731 per person per year for moderate and extreme poverty, respectively.

---

[114] Mahabub Hossain, Atiur Rahman, and M. M. Akash, *Agricultural Taxation in Bangladesh: Potential and Policies,* Research Report 42 (Dhaka: Bangladesh Institute of Development Studies, 1985).

[115] Bangladesh, Bureau of Statistics, *Bangladesh Household Expenditure Survey,* pp. 40-45.

It may be noted that the two methods described above yield almost the same poverty threshold income for an intake of around 2,200 kilocalories per person per day. Since the Bureau of Statistics estimate is based on a recent survey of a large number of households and is available for two alternative intakes of energy, the Bureau of Statistics norm has been applied to the income distribution data for this sample to estimate the proportion of population living below the poverty line.

The estimates are reported in Table 70. For the sample as a whole, 39 percent of the population were below the line of moderate poverty and 21 percent below the line of extreme poverty. The estimates are somewhat lower than those for rural Bangladesh derived from the 1983/84 household expenditure survey data, which show that 44 percent of the population had income below the moderate poverty line and 29 percent below the extreme poverty line. The national-level estimates are, however, comparable with the findings here for the underdeveloped villages.

Technological progress seems to have a significant impact on alleviation of rural poverty. The proportion of population below the moderate poverty line was 32 percent in the developed villages, compared with 47 percent in the underdeveloped villages, that is, about one-third of the poor has moved up the poverty line. The progress has been achieved mainly at the bottom of the income scale. The population under extreme poverty was only 15 percent in the developed villages, compared with 27 percent in the underdeveloped villages. For the landless group the proportion under moderate poverty was 63 percent for the entire sample; 51 percent in the developed villages, compared with 78 percent in the underdeveloped villages (Table 71). The proportion under extreme poverty for this group is down from 54 percent in the underdeveloped villages to 28 percent in the developed ones.

The head-count measure of poverty has the limitation of being insensitive to changes in the level and distribution of income among the poor. For a more significant assessment of the changes in poverty, two other indicators are suggested to supplement the head-count measure. These are the poverty-gap ratio, which measures the shortfall of the mean income of the poor from the poverty line, and the Gini concentration ratio of

Table 70—Estimates of incidence of poverty in technologically developed and underdeveloped villages, 1982

	Moderate Poverty			Extreme Poverty		
Indicator	Underdeveloped Villages	Developed Villages	All Villages	Underdeveloped Villages	Developed Villages	All Villages
Proportion of population in poverty	0.467	0.317	0.390	0.273	0.151	0.211
Poverty-gap ratio	0.329	0.264	0.303	0.262	0.216	0.246
Concentration of income among the poor (Gini ratio)	0.17	0.14	0.16	0.14	0.13	0.14
Sen's index of poverty	0.207	0.116	0.162	0.100	0.048	0.740

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

Table 71—Incidence of poverty, by landownership group and technology, 1982

	Moderate Poverty			Extreme Poverty		
Land Owned	Underdeveloped Villages	Developed Villages	All Areas	Underdeveloped Villages	Developed Villages	All Areas
(acres)	(proportion of total population in the group)					
0.50 or less	0.783	0.510	0.634	0.537	0.279	0.396
0.51–2.00	0.509	0.363	0.438	0.534	0.189	0.255
2.01 or more	0.285	0.174	0.228	0.089	0.080	0.081

Source: Based on data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

income for the poor. Sen has suggested a weighted index of poverty incorporating all three indicators. The Sen index is given by

$$P = H[I + (1 - I)G],$$

where P is the Sen index, H is the head-count ratio, I is the income-gap ratio, and G is the Gini coefficient of the income distribution of the poor.[116]

The estimates of the supplementary indicators of poverty and of the Sen index are reported in Table 70. The results are similar to that assessed by the head-count measure. The Sen index of poverty for developed villages is almost half of that in the underdeveloped villages, whether one takes the moderate or the extreme poverty line.

Conclusions

The potential for increasing rural incomes through diffusion of the modern technology is substantial. In technologically developed villages, where nearly three-fifths of the cropped land was under rice MVs, income was about 40 percent higher than in the villages where less than 10 percent of the area had been covered. Among farmers the income difference was found to be higher for large landowners, indicating a trend toward inequality, but for the landless the income difference was as high as for the large landowners. The top 20 percent in the per capita income scale have gained in relative terms, the bottom 40 percent have remained unaffected, while the middle 40 percent have been squeezed—although the absolute gain has been positive for all income groups. The Gini coefficient of concentration for household income was found to be the same (0.39) for both groups of villages, but the coefficient for per capita income was only marginally higher for developed villages.

Technological progress seems to have made a significant impact on alleviation of rural poverty. The proportion of people living below the poverty line, the poverty-gap ratio, and the concentration ratio of income of the poor are all lower in the technologically developed villages than in the underdeveloped villages. For the landless, the proportion of population living below the line of moderate poverty was estimated at 51 percent for the developed villages, compared with 78 percent for the underdeveloped villages. The Sen index of poverty was 0.116 for the developed villages—a substantial reduction when compared with the 0.207 estimated for the underdeveloped villages.

---

[116] A. K. Sen, "Poverty: An Ordinal Approach to Measurement," *Econometrica* 44 (March 1976): 219-231.

10

POLICY IMPLICATIONS

Technological progress is the key to overcoming the land constraint to growth of foodgrain production in Bangladesh. Indeed, the country has maintained the food-population balance in the postindependence period mainly through technological progress. Between 1970 and 1985 the area cropped with MVs increased by more than five times, from 1.2 to 6.9 million acres, and the consumption of chemical fertilizers increased from 0.15 million tons of nutrients to 0.59 million tons. Although the land under cultivation has remained stagnant at about 22.2 million acres, technological progress has made possible an acceleration of the rate of growth of crop production from 2.5 percent a year during 1950-71 to 2.9 percent during 1971-85, and of growth of cereal production from 2.6 to 3.4 percent during the same period. Technological progress has cut the unit cost of production of rice by about one-fifth and has increased gross profits per unit of land by 1.2 times. The analysis of detailed household data for 16 villages at different levels of technological development shows that all this may have been achieved with a somewhat neutral income distribution effect and a significant reduction in the incidence of rural poverty.

There is a vast potential for further diffusion of the new technology that will have to be exploited to feed the fast-growing population of the country. The following major policy directions are suggested by the study for realization of the potential.

Strengthening Agricultural Research and Extension

Credit for the diffusion of modern technology to present levels is mainly due to the Bangladesh Rice Research Institute (BRRI), which has done a commendable job of developing MVs that are suitable for local agroclimatic conditions and acceptable to consumer tastes. Support for the research effort is essential in order to continue the search for higher-yielding varieties that will increase production from the fixed amount of land and keep down the cost of production.

The new varieties have been adopted mainly for the dry season under irrigated conditions. In Bangladesh, however, rice is grown mainly under rain-fed conditions and the MVs have not found much acceptance for this production environment. More attention should be given to cropping system research on the possibility of adjustments in the existing cropping pattern that would encourage use of MVs in the monsoon season, and to development of higher-yielding varieties suitable for rain-fed conditions.

Diffusion of the modern technology is also constrained by other agroclimatic factors; for example, continuous deep flooding of a large proportion of land during the rainy season and high levels of soil salinity in the large coastal area. More attention should be given to investigating whether cost-effective, higher-yielding varieties could be developed for these unfavorable production environments.

The development of modern technology for rice and wheat has reduced the competitiveness of some noncereal crops, such as pulses and oilseeds, that are important as a source of protein for the poor. This study finds that in technologically developed villages only 10 percent of the cropped land is allocated to pulses, oilseeds, jute, and sugarcane, compared with about 26 percent in underdeveloped villages. Nationally, the sown area under noncereal crops declined from 22 percent during 1965-70 to 17 percent during

1980-85. Additional support is needed for research to develop suitable varieties for noncereal crops in order to make them competitive with rice and wheat MVs.

Farmers have experienced a faster increase in prices of modern agricultural inputs relative to output because initially these inputs were introduced at highly subsidized prices and the subsidies have been gradually phased out. There is still considerable subsidization of irrigation, and the reduction of subsidies may continue for some time. This phasing out has increased the unit cost of production and reduced the profits. These changes in relative input-output prices have affected the MVs most severely because they are heavy consumers of fertilizer and irrigation. The changes have also reduced the profitability gap between the traditional and modern varieties. It is estimated that between 1975/76 and 1984/85 the rate of profit over investment in working capital (cost of production) declined from 77 to 55 percent for the new varieties and from 49 to 43 percent for the traditional varieties (Chapter 4).

The adverse effect of the price trends on profits can be mitigated to some extent by increasing the efficiency of input use through more effective extension services. Bangladesh has long experience with agricultural extension and recently has reorganized it on the lines of a "Training and Visit" system, greatly increasing the number of extension agents at lower administrative tiers. The effectiveness of agricultural extension, however, remains a controversial issue. The gap in the yield of MVs and the response to chemical fertilizers achieved on government experimental farms is large compared with the results realized by farmers. Results of Bangladesh Rice Research Institute experiments reported by Zaman show that with 32 kilograms of nitrogen per acre, the yield for MVs increased to 2.45 tons for the boro season and 1.80 tons for the aman season.[117] With similar levels of fertilizer application during 1980-82, farmers actually produced 1.51 and 1.11 tons, respectively, during the boro and aman seasons. The response to fertilizer at farmers' fields is estimated at 4.3 units of paddy per unit of nutrient, compared with a 10:1 ratio under experimental conditions.[118] The gap cannot be completely eliminated, since most experiments do not represent farmers' conditions, but more effective extension services can reduce the gap and increase the profitability of cultivation.

Public Investment for Irrigation

The main vehicle for diffusion of the new technology has been development of irrigation facilities. It is the single most important determinant of adoption of the new technology. About 96 percent of the plots growing the new crops are irrigated, and the villages where the new technology has not yet developed are those that do not have access to irrigation facilities. In Bangladesh, however, irrigation facilities have been developed mainly by the government and mostly with foreign aid. Only about a fifth of the land has so far been brought under modern irrigation, although it is estimated that about three-fifths of the land could be irrigated with available ground- and surface-water resources.[119] The small size of farms, fragmented and scattered plots, and the indivisible nature of investment for irrigation development suggest that the private sector cannot be relied upon for investment in this field. The government has to take the leading role, as it has done in the past. During 1975-85 the government spent over 40 percent of the total development budget for the agricultural sector on water resource development, and the area irrigated by modern methods increased from 7 percent of cultivated land in 1974/75 to 21 percent in 1984/85. To maintain a moderate growth in cereal production and agricultural incomes, the government will have to maintain or even accelerate the allocation of public resources for investment in irrigation.

---

[117] S. M. H. Zaman, "Agronomic and Environmental Constraints on Fertilizer Effectiveness," in *Fertilizer Pricing Policy in Bangladesh*, ed. Bruce Stone (Washington, D.C.: International Food Policy Research Institute/Bangladesh Institute of Development Studies, 1987), p. 248.

[118] Hossain, "Fertilizer Consumption," pp. 183, 195.

[119] Bangladesh, Master Plan Organization, *National Water Plan, Summary Report* (Dhaka: Ministry of Irrigation and Flood Control, 1986), pp. 62-64.

The capacity of the government to accelerate investment in irrigation and to support agricultural research and extension will depend on the availability of finance. So far, the government has been largely dependent on external resources (foreign aid and loans) for financing such investment. The present low level of foodgrain prices in international markets and the political pressure from food-exporting developed countries suggest that it will be increasingly difficult to mobilize foreign aid for projects that increase foodgrain production. Uncertainty about the future availability of foreign aid and the increased cost of debt servicing suggest that it is advisable for the government to seek out internal resources.

In the past, the government has had limited success in mobilizing resources from the agricultural sector.[120] Direct agricultural taxes, collected mostly through land revenue, have lost considerable ground as a major source of government revenue since the early 1960s—the real value of tax receipts during 1979-82 was only about 30 percent of the level reached during 1958-61. In recent years, direct tax has tapped about 2.25 percent of nonagricultural incomes, whereas agriculture's terms of trade during 1975-85 did not show any consistent downward trend, and the recent level of domestic rice and wheat prices is considerably higher than the prices prevailing in international markets, indicating that producers are protected at the expense of consumers.

The government should take steps to mobilize additional resources from the agricultural sector. A move in that direction could be made by recovering the cost of public investment from the beneficiaries. Subsidies for fertilizer have been withdrawn, but the subsidy for irrigation is still large. Shallow tubewells are sold to farmers almost at a cost price, but in 1982/83 there was about a 73 percent subsidy on deep tubewells and 29 percent on low-lift pumps.[121] For large-scale irrigation projects implemented by the Water Development Board, both the capital and the current costs are borne almost entirely by the government. The benefits of the subsidy are reaped mostly by the owners of the irrigation equipment, who are large and medium landowners. The small farmers who buy water from the owners of the machines are charged almost the market clearing rates. Indeed, this study finds that the difference in the price of water is a major source of inequality in the distribution of income from the new technology (Chapter 6). The irrigation charge is one-fourth higher for the small farmers than for the large ones. Thus it may be advisable to withdraw the subsidy on sale of irrigation equipment, and also to reduce the budget share of large-scale irrigation projects for water resource development, since the cost recovery of large-scale projects has proved to be extremely difficult. The initial reaction of farmers to withdrawal of the subsidy may be adverse, which may temporarily slow the technological diffusion, but the adverse reaction should not last long. The difference in profits between cultivation of modern (irrigated) and traditional (unirrigated) varieties is about Tk 1,250 per acre at 1984/85 prices, and the withdrawal of irrigation subsidies would not eliminate this gap (Chapter 4). On the other hand, it would reduce the income disparities due to differential irrigation charges between farmers growing traditional and modern varieties, between technologically developed and underdeveloped regions, and between farmers with access to different irrigation projects and equipment.

---

[120] Hossain, Rahman, and Akash, *Agricultural Taxation in Bangladesh*, pp. 10-27.

[121] Osmani and Quasem, "Pricing and Subsidy Policies," p. 205.

Provision of Credit

The amount of loans obtained from both institutional and noninstitutional sources is found to be a significant determinant of adoption of the new technology (Chapter 6). This is understandable, since the working capital needs on account of purchased inputs—fertilizer, irrigation, and even hired labor—are much higher for the MVs than for the local varieties, for which most of the inputs are supplied from within the household. The cash cost of production at 1984/85 prices is estimated at Tk 2,120 per acre for MVs compared with Tk 800 for traditional varieties—an increase of about 165 percent. It is difficult for the small farmer to manage such a large investment from accumulated savings.

The government of Bangladesh recognizes the credit needs of the farmers. From 1975 to 1984, institutions that provide agricultural credit proliferated, and the number of bank branches operating in rural areas increased from 854 in 1975/76 to more than 3,200 in 1983/84. The supply of institutional credit at real value increased about eight times over this period. Credit disbursed during 1983/84 amounted to 7 percent of the value added in the agricultural sector—about 40 percent of the cost of material inputs and 2.3 times the cost of chemical fertilizers consumed in the country.[122] But owing to the weakness of the credit institutions, credit has remained concentrated in the hands of the medium and large farmers, and complicated loan-sanctioning procedures have led to untimely disbursement, which together with the spread of corruption among bank officials has promoted laxity in credit disciplines and poor recovery. The small farmers who need credit badly have suffered. They have to rely on noninstitutional markets where the cost of a loan is substantially higher, and to that extent they benefit less from utilization of the loan, compared with the medium and large farmers who have access to low-interest loans from institutional sources. Obviously, there is a need for overhauling the institutions and management of agricultural credit so that credit can be better targeted to smaller farmers. The government may consider elimination of subsidies on agricultural credit and a policy of variable cost of loan funds to banks, depending on the proportion of loans given to small and marginal farmers.

The findings of this study also point to the need for providing working capital loans to the poor so that they can generate more employment in the rural nonfarm sector. The increase in agricultural income from technological progress has a significant impact on the expansion of the market for nonfarm goods and services, which generates more employment opportunities in the nonfarm sector. But some working capital is needed for self-employment in these activities. The duration of self-employment in general, and in nonagriculture in particular, is found to be significantly related to the amount of nonland capital owned by the household (Chapter 7). Owing to the lack of capital, the poor cannot take full advantage of employment opportunities generated in nonfarm activities. The findings show that the additional employment in nonagriculture is taken up by the large landowning groups rather than by the landless (Chapter 7), and that the incremental income from nonagriculture is distributed in favor of the higher income groups (Chapter 9).

---

[122] Hossain, "Institutional Credit for Rural Development," pp. 3-5.

Experiments conducted by the Grameen Bank show that if credit is provided to the poor, they can generate productive self-employment in the nonfarm sector and significantly improve their standard of living.[123] The Grameen Bank provides loans to the landless without any collateral and recovers about 98 percent of the loans on time. The borrowers utilize the loans in family-based enterprises for livestock raising, cottage industries, and trade and shopkeeping, generating employment mostly for women. Since technological progress stimulates demand for these activities, the expansion of working capital loans for the poor in technologically developed areas should be considered to help generate more employment for the poor and improve income distribution.

---

[123] Hossain, "Credit for Alleviation of Rural Poverty."

APPENDIX:

SUPPLEMENTARY TABLES

Table 72—Estimates of growth equations for crop production, 1950-85

Crops/ Dependent Variable	Regression Coefficients					
	Constant Term	Time (T-1949)	Dummy (1 for 1971-85)	Time × Dummy	$\bar{R}^2$	'F' Statistic
Cereals						
Area	8.973	0.0110 (8.52)	−0.0525 (−0.75)	0.0006 (0.22)	0.88	85.4
Yield	8.340	0.0152 (8.10)	−0.2519 (−2.46)	0.0068 (1.73)	0.87	80.0
Production	10.405	0.0262 (10.09)	−0.304 (−2.16)	0.0074 (1.36)	0.91	122.0
Noncereals						
Area	7.289	0.0127 (3.78)	0.335 (1.83)	−0.0200 (−2.84)	0.27	5.3
Yield	8.639	0.0089 (4.78)	−0.1470 (−1.46)	0.0038 (0.97)	0.69	26.4
Production	9.021	0.0215 (6.45)	0.1878 (1.03)	−0.0162 (−2.31)	0.59	17.6
All crops						
Area	9.145	0.0112 (8.59)	−0.0008 (−0.01)	−0.0022 (−0.82)	0.85	66.0
Yield	8.486	0.0140 (9.38)	−0.233 (−2.86)	−0.0062 (1.96)	0.90	104.5
Production	10.631	0.0252 (11.60)	−0.234 (−1.98)	0.0039 (0.86)	0.92	140.7

Source: Estimated from official statistics from Bureau of Statistics, Bangladesh.
Notes: Dependent variables are measured in logarithms. Figures in parentheses are estimated t-values.

Table 73—Marginal budget shares and expenditure elasticity of demand for different commodities, 1982

Commodity Group	Underdeveloped Villages			Developed Villages		
	Average Share	Marginal Share	Expenditure Elasticity	Average Share	Marginal Share	Expenditure Elasticity
		(percent)			(percent)	
Crops	66.97	56.47	0.84	62.91	44.95	0.71
Rice	44.55	42.33	0.95	43.78	32.81	0.75
Wheat	8.42	−0.27	−0.03	5.33	−1.57	−0.29
Pulses	1.07	1.32	1.24	0.75	1.16	1.56
Roots	1.75	1.33	0.76	1.55	1.19	0.77
Vegetables	3.68	3.39	0.92	3.27	1.95	0.60
Spices	3.44	2.88	0.84	3.66	3.33	0.91
Betel nuts and betel leaves	0.91	1.42	1.55	1.34	1.34	1.00
Rice husks	0.53	0.35	0.65	0.21	0.24	1.16
Jute sticks	0.51	0.30	0.59	1.11	1.47	1.33
Fruits	2.12	3.42	1.62	1.92	3.02	1.57
Forestry	4.12	3.21	0.78	3.08	2.72	0.88
Firewood	2.02	2.59	1.29	1.53	2.06	1.35
Leaves	2.10	0.62	0.30	1.55	0.66	0.43
Livestock	4.43	5.70	1.29	4.00	6.35	1.59
Meat	1.12	2.47	2.20	1.74	3.80	2.18
Milk	0.94	1.82	1.93	1.25	2.41	1.92
Eggs	0.44	0.77	1.75	0.32	0.55	1.70
Cow dung	1.93	0.64	0.33	0.69	−0.41	−0.58
Fishery	3.55	4.22	1.19	4.35	5.32	1.22
Rural manufacturing	9.54	12.40	1.30	9.48	10.29	1.09
Gur (raw sugar)	1.59	2.20	1.39	1.50	2.11	1.41
Bidi (cigarettes)	1.48	0.72	0.48	1.37	0.79	0.57
Tobacco	0.17	0.25	1.42	0.17	−0.08	−0.44
Mustard oil	2.13	2.31	1.09	2.31	2.39	1.04
Sweets	0.06	0.15	2.44	0.06	0.14	2.48
Handloom clothing	3.77	5.98	1.58	3.70	4.22	1.14
Tailoring	0.35	0.79	2.29	0.38	0.73	1.94
Urban manufacturing	7.20	10.50	1.46	7.97	12.44	1.56
Mill-made clothing	0.52	1.38	2.63	0.97	1.89	1.94
Imported clothing	0.81	2.57	3.19	0.48	1.28	2.69
Old garments	0.29	0.20	0.66	0.28	0.15	0.53
Ready-made garments	0.42	0.79	1.86	0.51	0.87	1.73
Shoes	0.24	0.46	1.96	0.33	0.63	1.95
Sugar	0.28	0.30	1.08	0.35	0.88	2.50
Tea	0.06	0.06	1.00	0.35	0.70	2.01
Cigarettes	0.13	0.34	2.60	0.35	0.90	2.58
Soybean oil	0.34	0.19	0.57	0.13	0.25	1.90
Coconut oil	0.40	0.36	0.90	0.36	0.35	0.98
Kerosene oil	1.86	1.75	0.94	1.90	1.67	0.88
Electricity	. . .	. . .	. . .	0.07	0.22	2.98
Matches	0.40	0.12	0.30	0.40	0.21	0.51
Soap	0.94	1.35	1.44	1.01	1.61	1.59
Washing soda	0.25	0.15	0.62	0.10	0.05	0.47
Toiletry and cosmetics	0.07	0.18	2.50	0.17	0.33	2.00
Other	0.19	0.30	1.58	0.21	0.45	2.14
Services	4.20	7.50	1.79	8.21	17.93	2.18
Education	0.63	1.72	2.74	1.00	2.58	2.57
Health	1.36	1.90	1.39	2.49	4.58	1.84
Transport	0.73	0.95	1.30	0.98	1.93	1.96
Personal services	0.35	0.39	1.11	0.50	0.53	1.06
Religious services	0.60	1.25	2.10	2.38	5.48	2.30
Other services	0.53	1.30	2.44	0.86	2.83	3.28

Source: Estimated by fitting Engel functions to data from Bangladesh Institute of Development Studies/International Food Policy Research Institute field survey.

BIBLIOGRAPHY

Agarwal, Bina. "Tractors, Tubewells and Cropping Intensity in the Indian Punjab." *Journal of Development Studies* 20 (No. 4, 1984): 290-302.

Ahmad, Q. K., and Hossain, Mahabub. "An Evaluation of Selected Policies and Programs for Alleviation of Rural Poverty in Bangladesh." In *Strategies for Alleviating Poverty in Rural Asia,* pp. 67-98. Edited by Rizwanul Islam. Bangkok: International Labour Organisation, Asian Employment Programme, 1985.

Ahmed, Iftikhar. "Technological Change and Labor Utilization in Rice Cultivation: Bangladesh." *The Bangladesh Development Studies* 6 (No. 3, 1977): 359-366.

Ahmed, Iqbal. "Unemployment and Underemployment in Bangladesh Agriculture." *World Development* 6 (December 1978): 1281-1296.

Ahmed, Raisuddin. *Agricultural Price Policies under Complex Socioeconomic and Natural Constraints.* Research Report 27. Washington, D.C.: International Food Policy Research Institute, 1981.

______. "Structure, Dynamics, and Related Policy Issues of Fertilizer Subsidy in Bangladesh." In *Fertilizer Pricing Policy in Bangladesh.* Edited by Bruce Stone. Washington, D.C.: International Food Policy Research Institute/Bangladesh Institute of Development Studies, 1987.

Ahmed, Raisuddin, and Hossain, Mahabub. "Infrastructure and Development of a Rural Economy," International Food Policy Research Institute, Washington, D.C., July 1987 (mimeographed).

Alauddin, Mohammad, and Tisdell, Clem. "Market Analysis, Technical Change, and Income Distribution in Semi-Subsistence Agriculture: The Case of Bangladesh." *Agricultural Economics* 1 (No. 1, 1986): 1-18.

Asaduzzaman, M. "Adoption of HYV Rice in Bangladesh." The *Bangladesh Development Studies* 7 (No. 3, 1979): 23-49.

Bangladesh, Bureau of Statistics. *The Bangladesh Census of Agriculture and Livestock: 1983-84.* Dhaka: Ministry of Planning, 1986.

______. *Final Report: Labour Force Survey, 1983-84.* Dhaka: Ministry of Planning, 1986.

______. *Monthly Statistical Bulletin of Bangladesh,* various issues.

______. *Report of the Bangladesh Household Expenditure Survey, 1981-82.* Dhaka: Ministry of Planning, 1986.

______. "Report of the Bangladesh Household Expenditure Survey, 1983-84." Ministry of Planning, Dhaka, 1987 (mimeographed).

______. *Report on the Agricultural Census of Bangladesh, 1977* (National Volume). Dhaka: Ministry of Planning, 1981.

______. *Statistical Pocket Book of Bangladesh, 1986.* Dhaka: Ministry of Planning, 1987.

______. *The Statistical Yearbook of Bangladesh, 1984-85.* Dhaka: Ministry of Planning, 1985.

______. *Yearbook of Agricultural Statistics,* various issues. Dhaka: Ministry of Planning, various years.

Bangladesh, Department of Agricultural Marketing. "Wholesale Prices of Agricultural and Animal Products in Bangladesh, 1972-85." Ministry of Agriculture, Dhaka, 1986 (mimeographed).

Bangladesh, Master Plan Organization. *National Water Plan Project—Draft Final Report,* vols. 1 and 2. Dhaka: Ministry of Irrigation and Flood Control, 1985.

______. *National Water Plan, Summary Report.* Dhaka: Ministry of Irrigation and Flood Control, 1986.

Bangladesh, Ministry of Finance. *Bangladesh Economic Survey,* various issues. Dhaka: Government Press, various years.

Bangladesh Agricultural Development Corporation. *Annual Report,* various issues. Dhaka: BADC, various years.

______. *HYV Task Force Report, 1974/75, 1975/76.* Dhaka: BADC, 1977.

______. *Sale of Shallow Tubewells in the Northwest and Southeastern Districts of Bangladesh.* BADC, Dhaka, 1984 (mimeographed).

Bangladesh Institute of Development Studies/International Food Policy Research Institute. *Development Impact of the Food-for-Work Program in Bangladesh.* A report submitted to the World Food Programme. Washington, D.C.: IFPRI, 1985.

Bangladesh Unnayan Parishad. *A Socio-Economic Evaluation of the Chandpur II Irrigation Project.* A report prepared for the World Bank. Dhaka: Bangladesh Unnayan Parishad, 1982.

Bardhan, Pranab K. "Agricultural Development and Land Tenancy in a Peasant Economy: A Theoretical and Empirical Analysis." *American Journal of Agricultural Economics* 61 (No. 1, 1979): 48-56.

______. "Labor Supply Functions in a Poor Agrarian Economy." *American Economic Review* 69 (March 1979): 73-83.

______. "Size, Productivity, and Returns to Scale: An Analysis of Farm-Level Data in Indian Agriculture." *Journal of Political Economy* 81 (No. 6, 1973): 1370-1386.

Bardhan, Pranab K., and Srinivasan, T. N. "Crop Sharing Tenancy in Agriculture: A Theoretical and Empirical Analysis." *American Economic Review* 61 (No. 1, 1971): 48-64.

Barker, Randolph; Herdt, Robert W.; and Rose, Beth. *The Rice Economy of Asia.* Baltimore: Johns Hopkins University Press for Resources for the Future, 1985.

Bell, Clive; Hazell, Peter; and Slade, Roger. *Project Evaluation in Regional Perspective.* Baltimore and London: Johns Hopkins University Press, 1982.

Berry, Albert R., and Cline, William R. *Agrarian Structure and Productivity in Developing Countries.* Baltimore: Johns Hopkins University Press, 1979.

Bhaduri, Amit. "A Study in Agricultural Backwardness under Semi-feudalism." *Economic Journal* 83 (March 1973): 120-137.

Bhalla, G. S., and Chadha, G. K. *Green Revolution and the Small Peasant.* New Delhi: Concept, 1983.

Bharadwaj, Krishna. *Production Conditions in Indian Agriculture.* Department of Applied Economics Occasional Paper 33. Cambridge: Cambridge University Press, 1974.

Binswanger, Hans, and Ruttan, Vernon W. *Induced Innovation, Technology, Institutions and Development.* Baltimore: Johns Hopkins University Press, 1978.

Blyn, George. "The Green Revolution Revisited." *Economic Development and Cultural Change* 31 (No. 4, 1983): 705-725.

Boyce, James K. "Water Control and Agricultural Performance in Bangladesh." *The Bangladesh Development Studies* 14 (No. 4, 1986): 1-35.

Chand, Ramesh, and Kaul, J. L. "A Note on the Use of the Cobb-Douglas Profit Function." *American Journal of Agricultural Economics* 68 (No. 1, 1986): 162-164.

Chayanov, A. V. *The Theory of Peasant Economy.* Edited by Daniel Thorner. Homewood, Ill.: Richard D. Irwin, 1966.

Christensen, Laurits R.; Jorgensen, Dale W.; and Lau, Lawrence J. "Transcendental Logarithmic Production Frontiers." *Review of Economics and Statistics* 55 (No. 1, 1973): 28-45.

Cuddy, J. D. A., and Della Valle, P. A. "Measuring the Instability of Time Series Data." *Oxford Bulletin of Economics and Statistics* 40 (February 1978): 79-85.

Cummings, John T. "The Supply Response of Bangalee Rice and Cash Crop Cultivators." *The Bangladesh Development Studies* 2 (October 1974): 235-251.

Dalrymple, Dana G. *Development and Spread of High Yielding Rice Varieties in Developing Countries.* Washington, D.C.: U.S. Agency for International Development, 1986.

Dantwala, M. L. "Technology, Growth and Equity in Agriculture." In *Agricultural Change and Rural Poverty,* pp. 110-123. Edited by John W. Mellor and Gunvant M. Desai. Baltimore and London: Johns Hopkins University Press, 1985.

Dasgupta, Biplob. *The New Agrarian Technology and India.* New Delhi: Macmillan, 1977.

Farmer, B. H., ed. *Green Revolution.* London: Macmillan, 1977.

Feder, Gershon; Just, Richard; and Zilberman, David. "Adoption of Agricultural Innovations in Developing Countries: A Survey." *Economic Development and Cultural Change* 33 (No. 2, 1985): 255-298.

Flinn, J.; Kalirajan, K; and Castillo, L. "Supply Responsiveness of Rice Farmers in Laguna, Philippines." *Australian Journal of Agricultural Economics* 26 (No. 1, 1982): 39-48.

Ghose, Ajit K., and Saith, Ashwani. "Indebtedness, Tenancy and the Adoption of New Technololgy in Semi-feudal Agriculture." *World Development* 4 (April 1976): 305-320.

Greene, William H. "On the Asymptotic Bias of the Ordinary Least Squares Estimator of the Tobit Model." *Econometrica* 49 (No. 2, 1981): 505-513.

Griffin, Keith. *The Political Economy of Agrarian Change: An Essay on the Green Revolution.* Cambridge: Harvard University Press, 1974.

Hamid, M. Abdul. *Low-Lift Pumps under IDA Credit in South-East Bangladesh: A Socio-Economic Study.* Rural Development Studies, Series 12. Rajshahi: Rajshahi University, Department of Economics, 1984.

Hasan, Nazmul, and Ahmad, Kamaluddin. "Studies on Food and Nutrient Intake by Rural Population of Bangladesh." *Ecology of Food and Nutrition* 15 (No. 12, 1984): 143-158.

Hayami, Yujiro, and Herdt, Robert W. "Market Price Effects of Technological Change on Income Distribution in Semi-Subsistence Agriculture." *American Journal of Agricultural Economics* 59 (May 1977): 245-256.

Hazell, Peter B. R. *Instability in Indian Foodgrain Production.* Research Report 30. Washington, D.C.: International Food Policy Research Institute, 1982.

Hazell, Peter B. R., and Roëll, Ailsa. *Rural Growth Linkages: Household Expenditure Patterns in Malaysia and Nigeria.* Research Report 41. Washington, D.C.: International Food Policy Research Institute, 1983.

Herdt, Robert W., and Garcia, L. "Adoption of Modern Rice Technology: The Impact of Size and Tenure in Bangladesh." International Rice Research Institute, Manila, 1982 (mimeographed).

Herdt, Robert W., and Mandac, A. M. "Modern Technology and Economic Efficiency of Philippine Farms." *Economic Development and Cultural Change* 29 (No. 2, 1981): 374-399.

Herdt, Robert W., and Wickham, Thomas H. "Exploring the Gap Between Potential and Actual Rice Yields in the Philippines." *Food Research Institute Studies* 14 (No. 2, 1975): 163-181.

Hossain, Mahabub. "Agricultural Development in Bangladesh: A Historical Perspective." *The Bangladesh Development Studies* 12 (December 1984): 29-57.

______. "Agricultural Growth Linkages: The Bangladesh Case." *The Bangladesh Development Studies* 15 (No. 1, 1987).

______. *Credit for Alleviation of Rural Poverty: The Grameen Bank in Bangladesh.* Research Report 65. Washington, D.C.: International Food Policy Research Institute, 1988.

______. *Credit for the Rural Poor: The Grameen Bank in Bangladesh.* Research Monograph 4. Dhaka: Bangladesh Institute of Development Studies, 1984.

______. "Employment and Labour in Bangladesh Rural Industries." *The Bangladesh Development Studies* 12 (March-June 1984): 1-24.

______. "Farm Size, Tenancy, and Land Productivity: An Analysis of Farm Level Data in Bangladesh Agriculture." *The Bangladesh Development Studies* 5 (No. 3, 1977): 285-348.

______. "Fertilizer Consumption, Pricing, and Foodgrain Production in Bangladesh." In *Fertilizer Pricing Policy in Bangladesh.* Edited by Bruce Stone. Washington, D.C.: International Food Policy Research Institute/Bangladesh Institute of Development Studies, 1987.

______. "Foodgrain Production in Bangladesh: Performance, Potential and Constraints." *The Bangladesh Development Studies* 8 (Nos. 1 and 2, 1980): 39-70.

______. "Institutional Credit for Rural Development: An Overview of the Bangladesh Case." *The Bangladesh Journal of Agricultural Economics* 8 (No. 1, 1985): 1-16.

______. "Irrigation and Agricultural Performance in Bangladesh: Some Further Results." *The Bangladesh Development Studies* 14 (No. 4, 1986): 39-56.

______. "Nature of Tenancy Markets in Bangladesh Agriculture." *Journal of Social Studies* 3 (No. 1, 1977): 1-24.

______. "Productivity and Profitability of Bangladesh Rural Industries." *The Bangladesh Development Studies* 12 (March-June 1984): 127-161.

Hossain, Mahabub; Rahman, Atiur; and Akash, Mokaddam M. *Agricultural Taxation in Bangladesh: Potential and Policies.* Research Report 42. Dhaka: Bangladesh Institute of Development Studies, 1985.

Hossain, Mosharraf; Rashid, A; and Jahan, Selim. *Rural Poverty in Bangladesh: A Report to the Like-minded Group.* Dhaka: Dhaka University Press, 1986.

International Fertilizer Development Center. *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1979/80.* Muscle Shoals, Ala.: IFDC, 1982.

______. *Agricultural Production, Fertilizer Use, and Equity Considerations: Results and Analysis of Farm Survey Data, 1981/82.* Muscle Shoals, Ala.: IFDC, 1984.

International Food Policy Research Institute/Bangladesh Institute of Development Studies. *Fertilizer Pricing Policy and Foodgrain Production Strategy in Bangladesh, Technical Annex.* Washington, D.C.: IFPRI, 1985.

Ishikawa, Shigeru. *Economic Development in Asian Perspective.* Tokyo: Kinokuniya, 1967.

Islam, Rizwanul, ed. *Strategies for Alleviating Poverty in Rural Asia.* Bangkok: International Labour Organization, Asian Employment Programme, 1985.

Jannuzi, F. Tomasson, and Peach, James T. *Agrarian Structure of Bangladesh: An Impediment to Development.* Boulder, Colo.: Westview Press, 1980.

Kahnert, F.; Carmignani, R.; Stier, H.; and Thomopoulos, P. *Agriculture and Related Industries in Pakistan.* Paris: OECD Development Center, 1970.

Khan, Azizur R. "Poverty and Inequality in Rural Bangladesh." In *Poverty and Landlessness in Rural Asia,* pp. 137-160. Geneva: International Labour Organisation, 1977.

Khan, Mahmud M. "Labor Absorption and Unemployment in Rural Bangladesh." *The Bangladesh Development Studies* 13 (September-December 1985): 67-88.

Lau, Lawrence J., and Yotopoulos, Pan A. "Profit, Supply and Factor Demand Functions." *American Journal of Agricultural Economics* 54 (No. 1, 1972): 11-18.

______. "A Test for Relative Economic Efficiency and an Application to Indian Agriculture." *American Economic Review* 61 (No. 1, 1971): 94-109.

Lau, Lawrence J.; Lin, Wuu-Long.; and Yotopoulos, Pan A. "Inter-farm, Inter-regional and Farm-nonfarm Income Distribution: The Impact of the New Cereal Varieties." *World Development* 6 (No. 3, 1978): 319-337.

______. "The Linear Logarithmic Expenditure System: An Application to Consumption-Leisure Choice." *Econometrica* 46 (July 1978): 843-868.

Lipton, Michael. *Modern Varieties, International Agricultural Research, and the Poor.* CGIAR Study Paper 2. Washington, D.C.: World Bank, 1985.

Maddala, G. S. *Limited Dependent and Qualitative Variables in Econometrics.* Cambridge: Cambridge University Press, 1984.

Magor, Noel P. *Potential in Rainfed Transplanted Rice Production in North-East Bangladesh.* Dhaka: Bangladesh Rice Research Institute, 1984.

Mahmud, Wahiduddin. "Foodgrain Demand Elasticities of Rural Households in Bangladesh: An Analysis of Pooled Cross-Section Data." *The Bangladesh Development Studies* 7 (No. 1, 1979): 59-70.

Mandal, M. A. Sattar. "Farm Size, Tenancy and Productivity in an Area of Bangladesh." *The Bangladesh Journal of Agricultural Economics* 3 (December 1980): 21-42.

Mellor, John W. "Determinants of Rural Poverty: The Dynamics of Production, Technology, and Price." In *Agricultural Change and Rural Poverty,* pp. 21-40. Edited by John W. Mellor and Gunvant M. Desai. Baltimore and London: Johns Hopkins University Press, 1985.

______. "Food Price Policy and Income Distribution in Low-Income Countries." *Economic Development and Cultural Change* 27 (October 1978): 1-26.

______. *The New Economics of Growth: A Strategy for India and the Developing World.* Ithaca: Cornell University Press, 1976.

Newberry, David. "Tenurial Obstacles to Innovation." *Journal of Development Studies* 11 (July 1975): 263-277.

Osmani, S. R., and Quasem, M. A. "Pricing and Subsidy Policies for Bangladesh Agriculture." Bangladesh Institute of Development Studies, Dhaka, 1985 (mimeographed).

Pakistan, Agricultural Census Organization. *1960 Pakistan Census of Agriculture.* Karachi: Ministry of Food and Agriculture, 1962. Vol. 1, *East Pakistan.*

Pakistan, Central Statistical Office. *25 Years of Pakistan in Statistics.* Karachi: Government Press, 1972.

Pears, Andrew. *Seeds of Plenty, Seeds of Want: Social and Economic Implications of the Green Revolution.* Oxford: Clarendon Press, 1980.

Perrin, Richard, and Winkelmann, Don. "Impediments to Technical Progress on Small Versus Large Farms." *American Journal of Agricultural Economics* 58 (December 1976): 888-894.

Prahladachar, M. "Income Distribution Effects of the Green Revolution in India: A Review of Empirical Evidence." *World Development* 11 (No. 11, 1983): 927-944.

Press, S. J., and Houthakker, H. S. *The Analysis of Family Budgets.* Cambridge: Cambridge University Press, 1971.

Prey, Carl E., and Anderson, Jock A. *Bangladesh and the CGIAR Centers: A Study of Their Collaboration in Agricultural Research.* Study Paper 8. Washington, D.C.: World Bank, 1985.

Quasem, Md. Abul. *Impact of the New System of Distribution of Fertilizer and Irrigation Machines in Bangladesh—Survey Findings.* Research Report 62. Dhaka: Bangladesh Institute of Development Studies, 1987.

______. "Impact of the New System of Distribution of Irrigation Machines in Bangladesh." *The Bangladesh Development Studies* 13 (September-December 1985): 127-140.

Quiggin, John, and Bui-Lan, Anh. "The Use of Cross-Sectional Estimates of Profit Functions for Tests of Relative Efficiency: A Critical Review." *Australian Journal of Agricultural Economics* 28 (No. 1, 1984): 44-55.

Rahman, Atiq. "Surplus Utilisation and Capital Formation in Bangladesh Agriculture." *The Bangladesh Development Studies* 8 (No. 4, 1980): 21-46.

Rahman, Atiq, and Islam, Rizwanul. "Labor Use in Rural Bangladesh: A Study with Micro-Level Data." Asian Regional Team for Employment Promotion, International Labour Organisation, Bangkok, 1985 (mimeographed).

Rahman, Sultan H. "Supply Response in Bangladesh Agriculture." *The Bangladesh Development Studies* 14 (No. 4, 1986): 57-100.

Rangarajan, C. *Agricultural Growth and Industrial Performance in India.* Research Report 33. Washington, D.C.: International Food Policy Research Institute, 1982.

Rosenzweig, M. R. "Rural Wages, Labor Supply, and Land Reform: A Theoretical and Empirical Analysis." *The American Economic Review* 68 (December 1978): 847-861.

Roy, Prannoy. "Transition in Agriculture: Empirical Indicators and Results." *Journal of Peasant Studies* 8 (No. 2, 1981): 212-241.

Ruttan, Vernon W. "The Green Revolution: Seven Generalizations." *International Development Review* 19 (No. 4, 1977): 16-23.

Sen, Amartya K. "Poverty: An Ordinal Approach to Measurement." *Econometrica* 44 (March 1976): 219-231.

Shahabuddin, Quazi. "Testing of Cobb-Douglas Myths: An Analysis with Disaggregated Production Functions in Bangladesh Agriculture." *The Bangladesh Development Studies* 13 (No. 1, 1985): 88-97.

Shahid, A., and Herdt, Robert W. "Land Tenure and Rice Cultivation in Four Villages of Dhaka District, Bangladesh." *The Bangladesh Development Studies* 10 (No. 4, 1982): 113-124.

van Schendel, Willem. *Peasant Mobility: The Odds of Peasant Life in Bangladesh.* Assen, the Netherlands: Van Gorcum, 1981.

Yotopoulos, Pan A., and Lau, Lawrence J. "On Modeling the Agricultural Sector in Developing Economies." *Journal of Development Economics* 1 (No. 1, 1974): 105-127.

______. "A Test for Relative Economic Efficiency." *The American Economic Review* 63 (No. 1, 1973): 214-223.

Zaman, M. Raquibuz. "Sharecropping and Economic Efficiency in Bangladesh." *The Bangladesh Economic Review* 1 (No. 2, 1973): 149-172.

Zaman, S. M. Hasanuz. "Agronomic and Environmental Constraints on Fertilizer Effectiveness." In *Fertilizer Pricing Policy in Bangladesh.* Edited by Bruce Stone. Washington, D.C.: International Food Policy Research Institute/Bangladesh Institute of Development Studies, 1987.

Zellner, A. "An Efficient Method for Estimating Seemingly Unrelated Regressions and Test for Aggregation Bias." *Journal of the American Statistical Association* 57 (No. 2, 1962): 348-375.

RECENT IFPRI RESEARCH REPORTS (continued)

48 *RURAL HOUSEHOLD USE OF SERVICES: A STUDY OF MIRYALGUDA TALUKA, INDIA*, March 1985, by Sudhir Wanmali

47 *EVOLVING FOOD GAPS IN THE MIDDLE EAST/NORTH AFRICA: PROSPECTS AND POLICY IMPLICATIONS*, December 1984, by Nabil Khaldi

46 *THE EFFECTS ON INCOME DISTRIBUTION AND NUTRITION OF ALTERNATIVE RICE PRICE POLICIES IN THAILAND*, November 1984, by Prasarn Trairatvorakul

45 *THE EFFECTS OF THE EGYPTIAN FOOD RATION AND SUBSIDY SYSTEM ON INCOME DISTRIBUTION AND CONSUMPTION*, July 1984, by Harold Alderman and Joachim von Braun

44 *CONSTRAINTS ON KENYA'S FOOD AND BEVERAGE EXPORTS*, April 1984, by Michael Schluter

43 *CLOSING THE CEREALS GAP WITH TRADE AND FOOD AID*, January 1984, by Barbara Huddleston

42 *THE EFFECTS OF FOOD PRICE AND SUBSIDY POLICIES ON EGYPTIAN AGRICULTURE*, November 1983, by Joachim von Braun and Hartwig de Haen

41 *RURAL GROWTH LINKAGES: HOUSEHOLD EXPENDITURE PATTERNS IN MALAYSIA AND NIGERIA*, September 1983, by Peter B. R. Hazell and Ailsa Röell

40 *FOOD SUBSIDIES IN EGYPT: THEIR IMPACT ON FOREIGN EXCHANGE AND TRADE*, August 1983, by Grant M. Scobie

39 *THE WORLD RICE MARKET: STRUCTURE, CONDUCT, AND PERFORMANCE*, June 1983, by Ammar Siamwalla and Stephen Haykin

38 *POLICY MODELING OF A DUAL GRAIN MARKET: THE CASE OF WHEAT IN INDIA*, May 1983, by Raj Krishna and Ajay Chhibber

37 *SERVICE PROVISION AND RURAL DEVELOPMENT IN INDIA: A STUDY OF MIRYALGUDA TALUKA*, February 1983, by Sudhir Wanmali

36 *AGRICULTURE AND ECONOMIC GROWTH IN AN OPEN ECONOMY: THE CASE OF ARGENTINA*, December 1982, by Domingo Cavallo and Yair Mundlak

35 *POLICY OPTIONS FOR THE GRAIN ECONOMY OF THE EUROPEAN COMMUNITY: IMPLICATIONS FOR DEVELOPING COUNTRIES*, November 1982, by Ulrich Koester

34 *EGYPT'S FOOD SUBSIDY AND RATIONING SYSTEM: A DESCRIPTION*, October 1982, by Harold Alderman, Joachim von Braun, and Sakr Ahmed Sakr

33 *AGRICULTURAL GROWTH AND INDUSTRIAL PERFORMANCE IN INDIA*, October 1982, by C. Rangarajan

32 *FOOD CONSUMPTION PARAMETERS FOR BRAZIL AND THEIR APPLICATION TO FOOD POLICY*, September 1982, by Cheryl Williamson Gray

31 *SUSTAINING RAPID GROWTH IN INDIA'S FERTILIZER CONSUMPTION: A PERSPECTIVE BASED ON COMPOSITION OF USE*, August 1982, by Gunvant M. Desai

30 *INSTABILITY IN INDIAN FOODGRAIN PRODUCTION*, May 1982, by Peter B. R. Hazell

29 *GOVERNMENT POLICY AND FOOD IMPORTS: THE CASE OF WHEAT IN EGYPT*, December 1981, by Grant M. Scobie

28 *GROWTH AND EQUITY: POLICIES AND IMPLEMENTATION IN INDIAN AGRICULTURE*, November 1981, by J. S. Sarma

27 *AGRICULTURAL PRICE POLICIES UNDER COMPLEX SOCIOECONOMIC AND NATURAL CONSTRAINTS: THE CASE OF BANGLADESH*, October 1981, by Raisuddin Ahmed

26 *FOOD SECURITY IN THE SAHEL: VARIABLE IMPORT LEVY, GRAIN RESERVES, AND FOREIGN EXCHANGE ASSISTANCE*, September 1981, by John McIntire

Mahabub Hossain is a senior research economist and chief of the Human Resource Development Division at the Bangladesh Institute of Development Studies. He was a visiting research fellow at IFPRI from 1985 to 1987.

RECENT IFPRI RESEARCH REPORTS

66 *THE BRAZILIAN WHEAT POLICY: ITS COSTS, BENEFITS, AND EFFECTS ON FOOD CONSUMPTION,* May 1988, by Geraldo M. Calegar and G. Edward Schuh

65 *CREDIT FOR ALLEVIATION OF RURAL POVERTY: THE GRAMEEN BANK IN BANGLADESH,* February 1988, by Mahabub Hossain

64 *COOPERATIVE DAIRY DEVELOPMENT IN KARNATAKA, INDIA: AN ASSESSMENT,* December 1987, by Harold Alderman

63 *INCOME AND NUTRITIONAL EFFECTS OF THE COMMERCIALIZATION OF AGRICULTURE IN SOUTHWESTERN KENYA,* November 1987, by Eileen T. Kennedy and Bruce Cogill

62 *AGRICULTURAL RESEARCH IN NEPAL: RESOURCE ALLOCATION, STRUCTURE, AND INCENTIVES,* September 1987, by Ram P. Yadav

61 *THE PILOT FOOD PRICE SUBSIDY SCHEME IN THE PHILIPPINES: ITS IMPACT ON INCOME, FOOD CONSUMPTION, AND NUTRITIONAL STATUS,* August 1987, by Marito Garcia and Per Pinstrup-Andersen

60 *POPULATION POLICY AND INDIVIDUAL CHOICE: A THEORETICAL INVESTIGATION,* June 1987, by Marc Nerlove, Assaf Razin, and Efraim Sadka

59 *PRODUCTION INCENTIVES IN PHILIPPINE AGRICULTURE: EFFECTS OF TRADE AND EXCHANGE RATE POLICIES,* May 1987, by Romeo M. Bautista

58 *THE FOOD STAMP SCHEME IN SRI LANKA: COSTS, BENEFITS, AND OPTIONS FOR MODIFICATION,* March 1987, by Neville Edirisinghe

57 *CEREAL FEED USE IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 2000,* December 1986, by J. S. Sarma

56 *THE EFFECTS OF TRADE AND EXCHANGE RATE POLICIES ON AGRICULTURE IN ZAIRE,* November 1986, by Tshikala B. Tshibaka

55 *THE EFFECTS OF TRADE AND EXCHANGE RATE POLICIES ON AGRICULTURE IN NIGERIA,* October 1986, by T. Ademola Oyejide

54 *WEATHER AND GRAIN YIELDS IN THE SOVIET UNION,* September 1986, by Padma Desai

53 *REGIONAL COOPERATION TO IMPROVE FOOD SECURITY IN SOUTHERN AND EASTERN AFRICAN COUNTRIES,* July 1986, by Ulrich Koester

52 *FOOD IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 2000,* June 1986, by Leonardo A. Paulino

51 *DETERMINANTS OF AGRICULTURAL POLICIES IN THE UNITED STATES AND THE EUROPEAN COMMUNITY,* November 1985, by Michel Petit

50 *GOVERNMENT EXPENDITURES ON AGRICULTURE AND AGRICULTURAL GROWTH IN LATIN AMERICA,* October 1985, by Victor J. Elías

49 *LIVESTOCK PRODUCTS IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 1990 AND 2000,* April 1985, by J. S. Sarma and Patrick Yeung

(continued on inside back cover)

International Food Policy Research Institute
1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 USA